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# NUCLEAR SCIENCE ABSTRACTS

Volume 14 Number 13

July 15, 1960

## GENERAL AND MISCELLANEOUS

**12399** AECU-4681

Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev. BLANCA—A STUDY OF THE MAXIMUM VERTICAL EARTH MOTION OF THE MESA SLOPE. T[technical] M[emo] No. B-214 (Revised). D. Barnes and S. Finos. Feb. 1960. 19p. OTS.

Blanca, a 23 kiloton device, was detonated October 30, 1958, in a tunnel in Area 12 of the Nevada Test Site. The point of detonation was a vertical depth of 988 ft; the nearest point to the surface on the mesa slope was 835 ft. First apparent earth motion appeared ~3.6 sec after zero time; the maximum earth upheaval was reached ~5.5 sec after zero. Approximately 15.9 sec after zero, an earth rupture occurred on the mesa slope. (W.L.H.)

**12400** ORO-SP-131

Johns Hopkins Univ., Bethesda, Md. Operations Research Office.

FEASIBILITY AND COSTS OF HIGH-SPEED SHIPS FOR STRATEGIC DEPLOYMENT OF ARMY FORCES. William H. Sutherland. Jan. 20, 1960. 44p.

An investigation was made of the technical feasibility of using high-speed conventional ships for the deployment of Army forces, with attention being given to possible new ship design and the use of existing aircraft carriers. (W.L.H.)

**12401** SCR-150

Sandia Corp., Albuquerque, N. Mex.

SANDIA CORPORATION BIBLIOGRAPHY—CIVILIAN APPLICATION RELEASES THROUGH 1959. Jan. 1960. 85p. OTS.

A cumulative numerical listing is presented of the Sandia Corporation technical papers available to the public from the Office of Technical Services, Department of Commerce, Washington 25, D. C. Prices for printed, or photostatic and microfilm copies are included for many of the listings. Besides the new document releases from 1959, not contained in SCR-62, the revised title list includes a new section on engineering drawings and specifications now on sale through AEC's Engineering Materials Branch at Oak Ridge. The literature and engineering materials covered by the bibliography have been made available to the public under the Civilian Application Program of the Atomic Energy Commission by Sandia Corporation. (auth)

**12402** TID-3043(Rev. 1, Suppl. 1)

Technical Information Service Extension, AEC.

BIBLIOGRAPHIES OF INTEREST TO THE ATOMIC ENERGY PROGRAM. Hugh E. Voress, James M. Jacobs, and Naomi K. Smelcer, comps. Nov. 1959. 79p. OTS.

A compilation containing 561 references to bibliographies and literature surveys on various aspects of atomic energy is presented. References cited are to report and published literature. The bibliographies are arranged by issuing agency, as listed in the table of contents. Author, subject, and report number availability indexes are provided. (auth)

**12403**

LIABILITY INSURANCE AND THIRD PARTY RESPONSIBILITY IN THE CONSTRUCTION AND OPERATION OF REACTORS. H. Lillienfein. Atom u. Strom 6, 15-16 (1960) Feb. (In German)

The provisions of the German federal statutes with respect to liability insurance and third party responsibility in the construction and operation of reactors are described. The definitions of third party responsibility as used legally are reviewed. (J.S.R.)

**12404**

THE STATUS OF THE CANADIAN NEUTRON STANDARD. K. W. Geiger (National Research Council, Ottawa). Can. J. Phys. 38, 569-72(1960) Apr.

A comparison of the neutron standards of Sweden, Belgium, Germany, United Kingdom, United States, and Canada was made. (C.J.G.)

**12405**

THE ATOMIC ICEBREAKER. Yu. I. Klimov. Priroda 48, No. 12, 35-40(1959) Dec. (In Russian)

Descriptions are given of the equipment, power plant, protective measures, and other characteristics of the Lenin. (R.V.J.)

**12406**

Japan. National Diet Library, Tokyo.

A BIBLIOGRAPHY ON RADIOISOTOPES. 1959. 25p.

A bibliography is presented on radioisotopes and counting techniques in the fields of medicine, biology, physics, agriculture, engineering, chemistry, and instrumentation. 650 references are given to information appearing in journals, progress reports, conferences, or patents. (B.O.G.)

**12407**

GENSHIRYOKU HAKUSHO. (White Paper on Atomic Energy, Volume 1, 1957). Tokyo, Tsushosangyo Kenkyusha, 1957. 215p.

An annual report is given of developments in the application of atomic energy in Japan during 1957. The report describes the legal and historical background for the establishment of various governmental organizations; gives general descriptions of atomic reactors already built or conjectured; cites educational considerations in atomic energy; outlines efforts in producing atomic fuels, etc. Organiza-



tional charts, tabular summaries of the application of isotopes in Japan, and legal information are provided. (JPRS)

#### 12408

SYMPOSIUM OVER RADIOISOTOPEN IN DE CHEMIE. INGERICHT TE ANTWERPEN OF 22 EN 23 MAART 1957, IN SAMENWERKING MET DE KON. NED. CHEM. VERENIGING. (Symposium on Radioisotopes in Chemistry. Held at Antwerp from 22 to 23 March, 1957, in Cooperation with the Koninklijke Nederlandse Chemische Vereniging). Brussels, Vlaamse Chemische Vereniging, 1959. 102p.

The papers given at the symposium are presented. The topics discussed are "Sources of Error in Measurement Techniques in the Determination of the Strength of Radioactive Preparations," "Radioactive Rare Earths, Properties and Applications," "The Separation of Niobium and Tantalum in Chloro-oxalate Medium by Anion Exchange," "Application and Measurement of the Natural Radioactivity of Carbon," "General Precautions in the Use of Radioisotopes," "Application of Isotopes in the Investigation of Chemical and Biological Processes," and "Production of Isotopes in Belgium." (J.S.R.)

## BIOLOGY AND MEDICINE

### General and Miscellaneous

#### 12409 AF-SAM-60-22

School of Aviation Medicine, Brooks AFB, Tex. and Texas. Univ., Austin. Radiobiological Lab.

A NEW CHRONIC LOW-DOSE COBALT-60 FACILITY OF THE RADIOBIOLOGICAL LABORATORY. Joseph S. Pizzuto and Hugh L. Perry. Sept. 2, 1959. 6p.

The design is described of a low-dose cobalt-60 irradiation facility for use in chronic animal exposure studies. (C.H.)

#### 12410 AEC-tr-4004

HISTOLOGIC STUDY OF THE GONADS OF BLEAKS (ALBURNUS L.) EXPOSED TO SMALL CHRONIC DOSES OF  $U^{238}$ . M. M. Telitchenko and E. N. Levitova. Translated from *Vestnik Moskov. Univ., Ser. Biol. Pochvoved. Geol. i Geograf.* No. 1, 45-8(1959). 6p. JCL or LC.

Bleaks, *Alburnus alburnus* L., a small fish, were placed in water to which solutions of uranyl nitrate were added to make concentrations of 25, 10, 5, and 1 mg of uranium per liter of water. Degeneration of ovaries was observed in all female fish after 400 days. In fish maintained in 5 and 25 mg per liter doses of uranium, a degeneration of ovaries into testes was observed in bleaks. (C.H.)

#### 12411 NP-tr-424

INTERSTITIAL RADIOTHERAPY WITH UNSEALED RADIOACTIVE PREPARATIONS: AN EXPERIMENTAL CONTRIBUTION. Ernst Spode. Translated by R. Todd (U.K.A.E.A. Atomic Energy Research Establishment) from *Strahlentherapie* 108, 296-300(1959). 12p. JCL.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 9669.

#### 12412

THE ROTATION METHOD OF IRRADIATION IN RADIOBIOLOGY. P. F. Minaev, A. V. Bibergal', K. N. Emel'yanov (Emel'ianov), B. G. Zhukov, and A. A. Slepov (Inst. of Biological Phys., Academy of Sciences, Moscow). *Bio-physics* (U.S.S.R.) (English Translation) 4, No. 3, 136-8 (1959).

A convergent field was used to irradiate the cerebellum in guinea pigs. A device is described for rocking and rotating the animals under x-ray beam. (C.H.)

#### 12413

RADIOISOTOPES IN ANIMAL AND PLANT BIOLOGY. Orsini F. F. Nicola. *Fac. agron. y vet., Univ. Buenos Aires, Escuela agron., Bull.* No. 35, 98p. (1958). (In Spanish)

Chapters are included on the fundamentals of nucleonics and radiation, radiation effects and isotope applications, radioisotopes in animal physiology and veterinary medicine, and radioisotopes in the plant kingdom. (D.E.B.)

#### 12414

International Atomic Energy Agency, Vienna.

MEDICAL RADIOISOTOPE SCANNING. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959. 274p. (In English)

A seminar on medical radioisotope scanning, sponsored jointly by the International Atomic Energy Agency and the World Health Organization, was held at Vienna on February 25th through 27th, 1959. Separate abstracts have been prepared on 14 papers presented at this seminar. (C.H.)

#### 12415

Massachusetts. General Hospital, Boston.

THEORY OF ISOTOPE SCANNING. G. L. Brownell. p.1-12 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

The visualization of isotope distributions is an important aspect of the medical use of radioisotopes. The sensitivity patterns of various collimating systems are compared and their efficiency and resolution calculated. The collimating systems considered consist of cylindrical and tapered apertures, focusing collimators, and coincidence detection of annihilation radiation. A general theory is derived to give the optimum isotope concentration for each of the systems. A similar theory is derived to cover the scintillation camera and a comparison is made of the optimum isotope concentration of this device in relation to scanning methods. A modification of the camera concept for use with annihilation radiation is discussed. Various recording systems are compared as to efficiency and information presentation. (auth)

#### 12416

Chiba, Japan. Univ. Hospital.

PROBLEMS OF COLLIMATION. Hirotake Kakehi. p.13-29 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

Collimation is one of the most important problems in radioisotope scanning. It is closely related to the resolution of a scanning device. Any improvement in resolution is usually accompanied by a corresponding decrease in sensitivity, so that the design of a suitable collimator is the result of a compromise between resolution and sensitivity. A number of different types of collimators have been designed for clinical use. In order to determine the most suitable type of collimator for a specific diagnostic problem, the response pattern of the detector must be known. This pattern can best be visualized by constructing an iso-response curve which shows the absorption of the beam in a medium similar to human tissue. However, even by determining the relative dosage at various points of the path-



way of the beam in air, it is possible to demonstrate the characteristics of a collimator. Taking into account the various points mentioned above, the problems of choosing the most practical collimator for clinical scanning are discussed. (auth)

#### 12417

Roswell Park Memorial Inst., Buffalo.

PHOTOSCANNING. M. A. Bender and M. Blau. p.31-40 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

Isotope scanning permits the non-traumatic localization of several types of human tumors. To obtain satisfactory visualization, a scanner must be capable of resolving small differences in isotope content between target and non-target tissues and presenting this data in a readily interpretable form. In addition, it must have sufficient flexibility to be adaptable to the variety of activity levels and target:non-target ratios encountered clinically. Since for the most part isotope scanning is a diagnostic screening procedure, the over-all counting efficiency must be high so that the administered radioactivity can be kept as low as possible. A scanner meeting these needs has been constructed. The data presentation system, based upon the marked voltage dependence of the light output of a tungsten filament provides the high contrast necessary for visualizing small changes in count rate. It is possible to adjust the contrast and gain of the recording system to match the clinical requirements. A focusing collimator and large NaI crystal provide high efficiency, good resolution, and adequate depth response. This instrument has been successfully used for the localization of human tumors of the brain, liver, and thyroid. (auth)

#### 12418

Ontario Cancer Inst., Toronto.

BASIC PRINCIPLES OF SCINTILLATION COUNTING.

H. E. Johns and J. F. Cederlund. p.41-57 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

The effect of the energy of radiation, the crystal size, the collimation of the beam, and scattering on the pulse-height distribution produced by monoenergetic radiation is discussed. These aspects are related to scintillation scanning. The effects of voltage on the operation of photomultipliers and so-called plateaus are dealt with. Glow-transfer tubes for counting are dealt with and a useful subtraction circuit for comparing the counting rate from two separate scintillation counters is presented. (auth)

#### 12419

Roswell Park Memorial Inst., Buffalo.

DETECTION OF LIVER TUMORS WITH  $^{131}\text{I}$  ROSE BEN-GAL. M. A. Bender and M. Blau. p.83-6 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

It is possible to visualize tumors of the liver utilizing isotope scanning techniques.  $^{131}\text{I}$ -labeled Rose Bengal administered intravenously localizes quite specifically in functional liver tissue. Space-occupying lesions in the liver do not concentrate this dye and they therefore appear in the scans as areas of decreased radioactivity. Utilizing high contrast photocanning techniques and focusing collimators we have been able to make a correct diagnosis in 90% of the cases studied. Tumors 2 cm in diameter or larger anywhere in the liver are readily visualized. (auth)

matoms we have been able to make a correct diagnosis in 90% of the cases studied. Tumors 2 cm in diameter or larger anywhere in the liver are readily visualized. (auth)

#### 12420

Pisa, Italy. Università. Centro di Medicina Nucleare. LIVER SCANNING WITH COLLOIDAL RADIOGOLD.

L. Donato, M. F. Becchini, and S. Panichi. p.87-103 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

The authors report their experience in the use of colloidal  $\text{Au}^{198}$  for liver scanning. To obtain a good differentiation of liver from surrounding organs and tissues, a tracer dose of  $2.5 \mu\text{C/kg}$  is usually required. The whole scanning procedure, starting 30 minutes after intravenous injection, takes about 90 minutes, when carried out with fully automatic equipment. Upper and lateral liver contours are usually better defined than the lower one. The use of focusing collimators increases the resolution remarkably. In normal conditions the liver is the only organ clearly evident on the scan; the spleen may also become evident in some cases of splenomegaly and liver cirrhosis, probably on account of the reduction of reticuloendothelial system of the liver. In the experience of the authors, the efficiency of the technique is very poor for the detection of liver metastases of small size, not inducing changes of the volume and shape of the liver. In fact, uncertain results have been obtained even in cases of micronodular metastatic diffusion, confirmed at operation. The  $\text{Au}^{198}$  scanning may be of help in cases with diffuse or zonal enlargement, whatever the origin, in order to establish whether the changes are due to enlargement or normally functioning tissue, or to the presence of intrahepatic pathologic entities. It has been found very helpful to combine liver scanning with x ray examination of liver contours after carrying out a pneumoperitoneum, in order to compare anatomical and functional patterns. Scintigraphs and x ray contours are normally superimposable, and the finding of significant discrepancies may be helpful in evaluating the possibility of surgical or radiation treatment in patients with tumors, especially of the gastrointestinal tract. Of course, a negative result will not rule out the possibility of liver metastases. Original scintigraphs and corresponding x ray films are presented, and the results of major interest are discussed. (auth)

#### 12421

Massachusetts. General Hospital, Boston.

POSITRON SCANNING OF LIVER AND PANCREAS.

S. Aronow, R. Thors, and G. L. Brownell. p.105-24 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

The success of the positron scanning technique in the localization of brain tumors has suggested its application to other organs. Zinc-62 is used in an attempt to delineate the pancreas and copper-64 in various forms is used to delineate the liver. The problem of visualizing the pancreas is particularly difficult because of its small size and the presence of large organs in the vicinity which concentrate zinc. Several approaches to this problem are discussed. Copper-64 in simple ionic form and in the form of copper versenate concentrate to a marked degree in the liver. Positron scans of the liver would seem to offer considerable promise for successful diagnosis of various liver disorders. Data is presented on the distribution of several isotopes and compounds in animals. (auth)



## 12422

Berlin. Freie Universität. Strahleninstitut.  
THE DISTRIBUTION OF A PURE BETA-EMITTER IN THE HUMAN BODY. PROBLEMS AND PRELIMINARY RESULTS OF BREMSSTRAHLUNG MEASUREMENTS IN VIVO. H. G. Mehl. p.125-42 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

In vivo measurements of the distribution of a pure beta-emitter in the human body were previously limited to the localization of radioactivity in superficial tissues only, owing to the short range of the beta particles in tissue. During the last few years the analysis has been extended by means of bremsstrahlung measurements to activities in deep-lying tissues. The present paper deals with problems and results of this new technique. On the basis of an analysis of the physical nature of this radiation, the construction of suitable detection devices is discussed. The theoretical and experimental work done in this field are reviewed. In order to make a proper interpretation of the results obtained, it is necessary to analyze the various factors involved. These include particularly the area seen by the detector, the specific activity of the tissue seen and the depth of the organ under consideration. A discussion of the results of such measurements already published will permit an assessment of the present situation and of the nature of the problems still unsolved. (auth)

## 12423

London. Univ. University Coll. Hospital Medical School. PROFILE COUNTING. E. E. Pochin. p.143-62 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

In profile counting, a counter is moved progressively along the whole length of the body, and is so collimated that, at each position, it records the radioisotope content of the whole width of the body, but of only a short section of its length. If the counting rate at each position is plotted against the distance of the counter from the vertex of the head, the profile so obtained gives a rapid and quantitative measure of the radioisotope distribution throughout the body. When a suitable isotope is selectively concentrated in certain organs or tissues of the body, the profile will show peaks indicative of the sites and extent of such concentration, the organs concerned being identified by two-dimensional mapping, and profile counts continued to follow the turnover or changes of concentration in these organs. This technique has been used in the study of  $I^{131}$  concentration and metabolism in thyroid carcinomata, and its value in the management of the radioiodine treatment of such tumors is discussed. It has also been used in examining the distribution of labelled thyroxine and triiodothyronine after intravenous administration, and of yttrium-90 oxide particles after intrapulmonary artery injection; and of other isotopes by gamma radiation or bremsstrahlung. The method gives a clinically convenient simplification of whole body mapping which lends itself particularly to the quantitative comparison of isotope distribution at different intervals after a radioisotope dose, or after successive doses. (auth)

## 12424

Harvard Univ., Boston. Medical School and Massachusetts. General Hospital, Boston.  
COINCIDENCE SCANNING WITH POSITRON-EMITTING

ARSENIC OR COPPER IN THE DIAGNOSIS OF FOCAL INTRACRANIAL DISEASE. William H. Sweet, John Mealey, Jr., Gordon L. Brownell, and Saul Aronow. p.163-88 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

This is a report on coincidence counting in man of the paired annihilation gamma rays from positron-emitting copper or arsenic. The relevant biological behavior of inorganic arsenate and arsenite, of copper versenate, and the results of using these substances during automatic scanning to localize intracranial masses are discussed. (auth)

## 12425

Institut Pasteur. Institut National D'Hygiène, Paris.  
DIAGNOSIS OF INTRACRANIAL LESIONS BY GAMMA-ENCEPHALOGRAPHY, USING HUMAN SERUM ALBUMIN LABELLED WITH IODINE-131. Thérèse Planiol. p.189-211 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In French)

Six hundred patients were examined by means of serum albumin labeled with iodine-131. Radioactivity was read twice with a scintillation counter in contact with the skull, two hours and twenty-four hours after the radioactive injection. Of 175 intracranial tumors, 150 were accompanied by a focus of persistent gamma hyperactivity. Of those not detected by the examination, half were tumors of the hemispheres and half of the posterior fossa and pineal body. Abscesses, hematomata, and cirroid aneurisms were detected. In one-third of the cases acute cerebro-vascular lesions produced abnormal readings, half of which had the peculiar appearance pathognomonic of softening (or thrombosis); the others resembled tumor graphs, the only difference being that the abnormal readings associated with acute vascular lesions disappeared in a few weeks. Two-thirds of these acute lesions were associated with a negative gamma-encephalogram. Arterial aneurisms, non-tumorous epileptogenic foci, and various purely neurological conditions gave normal results in 96 per cent of cases. Brain investigation by radioalbumin can provide valuable information not only on the presence and exact location of a neurosurgical injury but also on its nature. In particular, it seems very likely to detect a meningioma, glioblastoma or metastatic growth. These properties, together with information on positive diagnosis and location, make it a specially useful neurodiagnostic method. Gamma-encephalography also seems likely to be one of the most reliable ways of detecting relapses and of following-up the effects of medical treatment or radiotherapy. (auth)

## 12426

Vienna. Universität.  
SCANNING IN NON-CANCEROUS THYROID DISEASE. Rudolf Höfer and Herbert Vetter. p.213-24 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

There are two main groups of application of scanning procedures in the diagnosis of non-cancerous thyroid disease. The first covers the determination of the size and shape of normal and enlarged glands and the localization of aberrant thyroid tissue such as lingual thyroids and intrathoracic goiters. Results of such studies are of particular assistance to the surgeon in planning his operative approach. The second group comprises studies of the radio-



iodine distribution within a nodular goiter. Particular attention is paid to those single or multiple nodules which concentrate radiiodine to a higher extent than the surrounding uninvolved tissue. A clear distinction is made between these hot nodules and the toxic nodules which, in addition, are associated with clinical symptoms of thyrotoxicosis. Repeated scintigraphic studies following administration of thyrotropic hormone and desiccated thyroid are of value in the differential diagnosis of such nodules. (auth)

**12427**

University of Southern California, Los Angeles.  
SCANNING IN THYROID CANCER. Franz K. Bauer.  
p.225-53 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

Scanning in thyroid cancer is of value in the preoperative diagnosis of a thyroid nodule; the localization of thyroid cancer metastases; and the treatment of thyroidectomized patients with metastases from thyroid cancer. The appearance of thyroid nodules on the scintigram is described. Some preliminary results of the use of radiophosphorus and external counting with a Geiger-Mueller tube of cold nodules are reported. Localization of thyroid cancer metastases with particular emphasis on the use of thyrotropic hormone is described. With this method three-fourths of all patients with metastatic thyroid cancer were found to have functioning metastases. The technique of ablation of normal thyroid remnants following total thyroidectomy and the treatment of metastases is discussed in detail. Scanning of metastases is the best method to follow the patient's progress. (auth)

**12428**

International Atomic Energy Agency, Vienna.  
RADIOISOTOPE TELETHERAPY EQUIPMENT—  
INTERNATIONAL DIRECTORY. 1959. 122p. \$2.00.  
(IAEA)

Information is summarized on the specifications and features of various models of radioisotope teletherapy units available in 1959. The gamma sources described employ cobalt-60 or cesium-137 as energy source. (C.H.)

**12429**

METAL-BINDING IN MEDICINE. PROCEEDINGS OF A SYMPOSIUM SPONSORED BY HAHNEMANN MEDICAL COLLEGE AND HOSPITAL, PHILADELPHIA. Marvin J. Seven and L. Audrey Johnson, eds. Philadelphia, J. B. Lippincott Company, 1960. 410p.

This book is a collection of formal papers and panel discussions from a meeting held in Philadelphia on May 6, 7, and 8, 1959, on the uses of metal-binding agents in medicine. Topics discussed cover basic concepts in trace metal research and clinical applications of some of the metal-binding agents. The metal-binding compounds are also considered as a means of introduction of metals into the body. Applications of the metal-binding principle in certain broad fields of clinical therapy are explored. Several chapters are included on the use of chelating agents for the removal of radioelements from the body. The appendix carries a series of formulas of pertinent compounds. A complete subject index and several hundred references are included. (C.H.)

**12430**

STRALENBIOLOGIE, GRUNDLAGEN UND ERGEBNISSE. (Radiobiology, Basis and Conclusions). Hedi Fritz-Niggli. Stuttgart, Georg Thieme Verlag, 1959. 390p.

This book is intended to give in a single work a complete

review of the present status in radiobiology for researchers and students. The topics covered are: physical basis for radiobiology, radiation chemistry, radiation biochemistry, radiation genetics, cells and cell division, effects of radiation on embryo, fetus, and the developing organism, regeneration, radiation and cancer, radiation pathology and radiation death, radiation sickness in mammals and man, biological and chemical means for prophylaxis and therapy of radiation injuries, and interpretation, theory, and future prospects. (Over 1,000 references). (T.R.H.)

## Biochemistry, Nutrition, and Toxicology

**12431**

CHANGES OF THE PROTEIN METABOLISM IN ANIMALS DURING RADIOPHOSPHORUS ADMINISTRATION. I. V. Savitskiĭ. *Med. Radiol.* 5, No. 2, 50-54(1960) Feb. (In Russian)

Experiments were performed on rabbits subjected to anemization, 6 bleedings within 21 days with the blood loss equal to 2% of the body weight. The changes in the nitrogen-protein blood composition and urine chemistry were studied during administration of radiophosphorus in toxic quantities (0.3 mC/kg). Under the effect of internal irradiation considerable changes took place in the indices of the protein metabolism in comparison with those occurring only in analogous anemization. The essence of these changes consisted of the following: under the effect of toxic quantities of  $P^{32}$ , the blood plasma globulin and fibrinogen levels rose; the concentration of residual nitrogen and urea in the blood increased; the level of aminoacids was reduced in the blood (in the plasma and erythrocytes); the ability of the latter to bind aminoacids diminished; and in the urine the content of creatinine and creatine was altered and other shifts in its chemical composition took place. (auth)

**12432**

SOME DATA ON THE TRANSITION OF  $S^{35}$  MERCAMIN THROUGH THE PLACENTA AND ITS DISTRIBUTION IN MATERNAL AND FETAL ORGANS. V. I. Bodyazhina and A. P. Kiryschenkov. *Med. Radiol.* 5, No. 2, 58-62(1960) Feb. (In Russian)

The transmission of  $S^{35}$  mercamin from the mother to the fetus was studied. Experiments were staged on 50 white female rats, of which 12 were nongravid, 13 had a 13-day pregnancy, and 25 had a 21-day pregnancy. Labeled mercamin was introduced intraperitoneally (20 mc per animal). The  $S^{35}$  activity in the organs of the mother and fetuses (21st intrauterine day) was assessed 15 minutes after the introduction of the preparation. It was established that the  $S^{35}$  distribution in the organs of gravid and non-gravid animals is more or less similar. Toward the end of pregnancy the accumulation of  $S^{35}$  in the gravid uterus intensifies. The placenta accumulated  $S^{35}$  to a lesser degree than the uterus and checked its transition from the mother to the fetus. The  $S^{35}$  accumulation in the fetal organs was several times lesser than in the corresponding maternal organs. (auth)

**12433**

HISTOCHEMICAL TEST FOR CERIUM IN TISSUES. J. Fischer, V. Fišerová-Bergerová, and E. Vašáková. *Pracovní lékařství* 12, 26-7(1960) Feb. (In Czech.)

A histochemical method is presented for determining cerium in tissues, using brompyrogallol red, which at pH 7.2 forms with  $Ce^{3+}$  a blue complex. The method is

suitable for frozen and paraffin sections. The selectivity of the method was determined. (auth)

**12434**

THE INCORPORATION OF LEUCINE- $C^{14}$  INTO PROTEIN BY A CELL-FREE PREPARATION FROM MAIZE KERNELS. Robert Rabson and G. David Novelli (Oak Ridge National Lab., Tenn.). *Proc. Natl. Acad. Sci. U. S. A.* **46**, 484-8(1960) Apr.

A system from developing maize endosperm consisting of washed particles plus a pH 5.2 fraction from the supernatant that actively incorporates leucine- $C^{14}$  into protein is described. The system requires a source of energy and GTP. The incorporation is inhibited by treatment with ribonuclease or chloramphenicol. When operating optimally, the incorporation efficiency is 1 to 2 per cent of the added isotope making this system comparable to the mammalian systems. (auth)

**12435**

QUANTUM PHENOMENA IN BIOLOGY. Natural, Ultraviolet, and High-energy Radiation Processes are Compared. C. Reid (Univ. of British Columbia, Vancouver). *Science* **131**, 1078-84(1960) Apr. 15.

A discussion is given of phenomena in which the absorption or emission of energy is clearly demonstrable as initiating or terminating a sequence of biochemical events. The events resulting from natural, ultraviolet, and high-energy radiation processes are compared. The energy transfer mechanisms of biochemical events are discussed. The physical mechanisms of the irradiation-induced phenomena of photodynamic action and photoreactivation are discussed. (C.J.G.)

## Fallout and Radiation Ecology

**12436** UWFL-61(Del.)

Washington. Univ., Seattle. Lab. of Radiation Biology. GROSS BETA RADIOACTIVITY OF THE ALGAE AT ENIWETOK ATOLL, 1954-1956. Ralph F. Palumbo. Aug. 31, 1959. Decl. with deletions Jan. 14, 1960. 36p. Contract AT(45-1)-540. OTS.

A study was made to determine the amounts of radioactivity in marine algae, water, and lagoon bottom sand collected at Eniwetok Atoll during the period April 1954 to April 1956. The highest levels of beta radioactivity of algae collected after the detonation of a nuclear device (Nectar) were in algae from those islands closest to the site of detonation and in the downwind path of the fallout. With time after detonation, the decline of radioactivity in the algae at Belle Island was faster than can be accounted for on the basis of physical decay alone. In March 1955, algae and bottom sand collected in the deeper waters (20 to 140 feet) of the lagoon, one half to two miles offshore, contained as much or more radioactivity than samples collected in the shallow water near shore. The radioactive decay rates of algae samples collected from Leroy and Henry Islands were greater than those of algae from other islands, indicating that there was less residual contamination from previous detonations at these two islands. Study of the radioactive decay rates of the algae at Belle Island showed that the radioactivity was decaying at a relatively low rate, which became slower with samples collected late in the survey. These observations indicate that the longer-lived isotopes were being taken up by the algae. (auth)

**12437** AEC-tr-4003

STUDIES ON RADIOACTIVE CONTAMINATION OF HUMAN ENVIRONMENT. I. SOILS AND PLANT LIFE. (Studien

zur Radioaktiven Kontamination der Menschlichen Umwelt. I. Boden und Pflanzenwelt). W. Herbst. Translated for Oak Ridge National Lab. from *Atompraxis* **5**, 280-4(1959). 21p. (Includes original, 5p.). JCL.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, as abstract No. 2289. (C.H.)

**12438**

MEASUREMENT OF THE ARTIFICIAL RADIOACTIVITY OF THE AIR AND OF FALL-OUT. P. Amadest, A. Cervellati, C. Melandri, and O. Rimondi. *Assoc. geofis. ital. Atti conv. Ann.* **8**, 61-81(1959). (In Italian)

The results of the measurement of the artificial radioactivity of the air and of fall-out made in Italy from June 1958 to February 1959 are reported. The measurement stations were located at Bologna, Milan, Genoa, Trieste, Naples, Resina, and Bari. The techniques for collecting the samples and measuring their activity are described. Histograms of the activity obtained at the various stations are given. The meteorological factors affecting the activity and the correlation with nuclear explosions are discussed. The methods used to separate  $Ba^{137}$ ,  $Sr^{90}$ , and  $Sr^{89}$  in the fall-out samples are given. The gamma spectra obtained are discussed. (J.S.R.)

**12439**

THE "ALIVERTI" METHOD FOR THE MEASUREMENT OF THE ATMOSPHERIC RADIOACTIVITY IN THE ABSENCE OF RADIOACTIVE EQUILIBRIUM. P. Vittozzi (Università, Naples). *Assoc. geofis. ital. Atti conv. Ann.* **8**, 97-107(1959). (In Italian)

The method proposed and applied by Aliverti for the quantitative measurement of the atmospheric radioactivity in the simple case in which only the first three solid products of Ra and Th ( $RaA$ ,  $RaB$ , and  $RaC$  and  $ThB$ ,  $ThB$ , and  $ThC$ ) coming from Rn and Tn are considered present in equilibrium with the respective emanations is extended to the general case. In the general case all the solid products derived from radon and thoron (from  $RaA$  to  $RaF$  and from  $ThA$  to  $ThC'$  and  $ThC''$ ) are considered without postulating the existence of equilibrium conditions. (tr-auth)

**12440**

RADIOACTIVITY OF THE AIR AND PRECIPITATION AT SOIL LEVEL IN THE REGION OF PARIS. C. Jehanno, O. Tanaevsky, J. Labeyrie, and E. Vassy. *J. mécan. phys. Atmosphère* (2) **1**, 1-23(1959) Jan.-Mar. (In French)

The methods of measuring the natural and artificial radioactivity of the atmosphere are described and the results obtained at Saclay, Paris, and Val Joyeux since 1955 are presented. Correlations between the natural radioactivity and meteorological elements (temperature, wind direction, velocity, and precipitation) are shown. The values of artificial radioactivity measured in the air and in the precipitation are particularly significant in the latter; the mean values in precipitation for two years being 50 times the maximum permissible dose. This radioactivity comes particularly from the stratosphere where it accumulated since the beginning of nuclear test explosions. (auth)

**12441**

RESULTS OF MEASUREMENT OF ARTIFICIAL RADIOACTIVITY OF THE ATMOSPHERE IN CZECHOSLOVAKIA. Vilém Santholzer (Charles Univ., Prague). *Jaderná energie* **6**, 16-20(1960) Jan. (In Czech.)

The results of measurements of artificial radioactivity of atmospheric precipitations for a period of 32 months, and of the radioactivity of nuclear fall-out during the



last 8 months, i.e., in the interval after the stopping of nuclear tests, are evaluated. The dependence of decay rate on the age of the specimen up to the period of two years is demonstrated, using several decay curves. The age index of several specimens with light masses was roughly determined. (auth)

#### 12442

NEW RESULTS OF MEASUREMENTS OF AIR RADIOACTIVITY IN VIENNA AND THE STRONTIUM-90 CONTENT OF PRECIPITATION IN VIENNA AND KLAGFURT.

Ferdinand Steinhauser (Zentralanstalt für Meteorologie und Goedynamik, Vienna). *Mitt. Österr. Sanitätsverwalt.* 60, No. 11, 3p.(1959). (In German)

Measurements of air radioactivity are tabulated for Jan.-Aug. 1959 and Sr<sup>90</sup> content of precipitation in Vienna and Klagfurt for Jan. 1958 to March 1959 and discussed. (T.R.H.)

#### 12443

DETECTION OF RECENTLY PRODUCED FISSION PRODUCTS IN THE ATMOSPHERE. W. Anderson, R. E. Bentley, L. K. Burton, and C. A. Greator (Royal Cancer Hospital, London). *Nature* 186, 223-4(1960) Apr. 16.

An increase in atmospheric radioactivity between February 28 and March 1, 1960, was attributed to the February 13, 1960, nuclear weapon test in the Sahara. The first measurements were made at Sutton, Surrey, England, 20 days after fission. The decay curve was very close to that to be expected from the mixture of fission products released by a nuclear explosion. The decay curves for three air samples collected by three separate methods are presented and discussed. (C.H.)

#### 12444

RADIOACTIVITY OF THE ATMOSPHERE DUE TO DISTANT NUCLEAR TEST EXPLOSIONS. D. H. Peirson, R. N. Crooks, and E. M. R. Fisher (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nature* 186, 224-5(1960) Apr. 16.

Data from measurements of atmospheric radioactivity made at 47,000 ft in the lower stratosphere and between 1,700 and 18,000 ft in the troposphere between 1957 and 1958 are analyzed and compared with a calendar of nuclear test explosions. The concentration of cesium-137 in the troposphere appears to follow a seasonal variation, with peaks about May and troughs in the autumn. The ratio of zirconium-95/cesium-137 was found to be a useful index of the age or origin of a mixture of fission products. The proportion of new activity may be calculated from the isotope ratios. (C.H.)

#### 12445

CONTEMPORARY CARBON-14 IN LEMONGRASS OIL. F. N. Hayes, E. Hansbury, V. N. Kerr, and D. L. Williams (Los Alamos Scientific Lab., N. Mex.). *Z. Physik* 158, 374-8(1960). (In English)

Liquid scintillation counting of p-cymene, derived from lemongrass oil, has provided information on the worldwide increase in C<sup>14</sup> since 1954. By June 1959, the activity in the tropospheric atmosphere and in the rapidly equilibrating biosphere is measured to have increased by 26.8% in the northern hemisphere and 19.7% in the southern hemisphere. The shape of the relationship between activity and time is essentially linear, with two sections of quite different slope. (auth)

#### 12446

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires.  
ESTUDIO DE LA CONTAMINACIÓN DEL PROCHILODUS

PLATENSIS (SÁBALO) CON PRODUCTOS DE FISIÓN. Informe No. 15. (Study of the Contamination of *Prochilodus Platensis* (Sábalo) with Fission Products). Report No. 15. Leopoldo José Anghileri. 1959. 19p.

The absorption of fission products in the *Prochilodus platensis* (Sábalo) was studied by determination of their specific activity in different organs and tissues 1, 2, 3, 10, and 30 days after contamination of the water. Contamination of the fish starts by adsorption on the mucous coating. Activity in stomach and guts, liver and kidney increases, presumptively, because of adsorption from the mud particles on which the fish feeds. Radiochemical analysis of the scales showed that the Sr<sup>90</sup> is fixed prevalently on them. (auth)

#### 12447

FALLOUT. A STUDY OF SUPERBOMBS, STRONTIUM 90, AND SURVIVAL. John M. Fowler, ed. New York, Basic Books, Inc., 1960. 242p.

Topics discussed include nuclear bombs and their products, the role of strontium-90 in fall-out hazards, the global pattern of fall-out, the route by which fall-out enters the body and where it concentrates after entering the body, the rising level of fall-out, biological effects of radiation, the effects of radiation on future generations, radiation accidents, the protection and treatment of radiation injuries, civil defense, the detection of bomb tests, nuclear war, and national survival. The author states that he would prefer to see time, energy, and money spent on purposes more productive than civil defense. He states that we must find an alternative to war rather than to make it possible again. He concludes that if we can banish the blight of war from the earth, then perhaps man can at last come out of the cave in which he has so long dwelt and walk upright in a land where the tamed nucleus powers his machines and the oceans are his fuel. (C.H.)

## Radiation Effects on Living Tissues

#### 12448 BNL-3624

Brookhaven National Lab., Upton, N. Y.  
CATALINA CONFERENCE. SESSION III—SENSITIVITY OF DIFFERENT CELLS IN THE SAME ORGANISM. V. P. Bond. Mar. 6, 1958. 16p. OTS.

Possible mechanisms affecting the radiosensitivity of cells are discussed. Factors contributing to the variations in radiosensitivity of tissues and organs in the same organisms are reviewed. The role of the proliferative activity of cells and tissues as a partial explanation of differing radiosensitivity of cells in the same organism is considered. (C.H.)

#### 12449 ORO-SP-127

Johns Hopkins Univ., Bethesda, Md. Operations Research Office and Walter Reed Army Medical Center. Inst. of Research, Washington, D. C.  
SYMPOSIUM ON THE DELAYED EFFECTS OF WHOLE-BODY RADIATION, OCTOBER 29, 1959. Bernard B. Watson, ed. Feb. 1960. 82p.

A symposium on the delayed effects of whole-body radiation was held at Bethesda, Maryland, on October 29, 1959. Separate abstracts have been prepared on seven papers presented at this symposium. (C.H.)

#### 12450 ORO-SP-127(p.3-10)

Argonne National Lab., Lemont, Ill.  
PROBLEMS IN THE EXTRAPOLATION OF LONG-TERM EFFECTS FROM ANIMALS TO MAN. George A. Sacher. 8p.

Problems in the extrapolation of long-term radiation effects from animals to man are discussed. It is necessary to understand the statistical relation between probability of death and the physiological state if a sound quantitative understanding of the way in which environmental factors affect survival is attained. An equation is presented for relating injury and probability of mortality in a simple, schematic case. Results are discussed. It is concluded that the relation between injury and life shortening is not a simple one. (C.H.)

**12451 ORO-SP-127(p.11-16)**

National Cancer Inst., Bethesda, Md.

**EFFECT OF CHRONIC IONIZING RADIATION ON THE LIFE SPAN OF MAN.** Nathaniel I. Berlin. 6p.

There are no data at present that can be used to quantify the effects of ionizing radiation on the life span of man. Shortening of life span is probably the most sensitive and in some instances the only means of measuring the late effects of radiation. There are some experimental data based on studies in rodents. Problems involved in the projection of this data to man are discussed. (C.H.)

**12452 ORO-SP-127(p.19-37)**

Los Alamos Scientific Lab., N. Mex.

**INCIDENCE OF TUMORS IN ANIMALS EXPOSED TO WHOLE-BODY RADIATION.** Irene U. Boone. 19p.

Results are reviewed from studies on animals which demonstrate the carcinogenic potency of ionizing radiation. Data from extensive studies on mice are presented which confirm the previous findings. An attempt was made to determine reaction mechanisms involved in tumor production. Tumor yield and kind of cancer formed appear to be dependent on type and location of the radiant energy absorbed. Action of the radiation may depend on the dose rate, specific ionization, and the particular tissue or organs irradiated. Age, sex, hormonal activity, and unknown physiological factors influence tumor induction. The increased frequency of neoplastic disease is seen as a delayed effect of either acute, continuous, or fractional exposure. Experimental evidence tends to indicate a multiplicity of mechanisms by which neoplasms are produced by ionizing radiation. Both direct and indirect effects are implicated. Mice have proved to be the most susceptible species to the induction of spontaneous leukemia, but the pathogenesis of leukemia induction in mice by ionizing radiation is still unknown. Extrapolation of data from animal studies to man is discussed. (C.H.)

**12453 ORO-SP-127(p.38-48)**

Rochester, N. Y. Univ. Strong Memorial Hospital.

**MALIGNANT DISEASE IN POPULATION GROUPS EXPOSED TO IONIZING RADIATION.** L. H. Hempelmann. 11p.

Data are reviewed on the incidence of malignant disease in five groups of irradiated individuals. These include children exposed to partial-body radiation, British patients with ankylosing spondylitis treated with x rays to the spine, Japanese survivors of the atomic bombings, American radiologists, and children exposed to radiation prenatally. The limitations involved in a survey of this nature are discussed. From a review of the available data it is concluded that there is no question about the association of prior irradiation and the increased incidence of leukemia in practically all groups studied. In adults there is a relation between dose and incidence in the higher dose range. In children such a relation has not been established, possibly because of the small number of cases studied. The data in man are insufficient to permit statements to be made about the existence of a threshold dose or the induction rate of

leukemia at lower doses of radiation. Children may be somewhat more susceptible to leukemia induction than adults, as is indicated by the fact that quite a few cases occurred with doses below 200 r. In these studies it seems that the volume of tissue exposed as well as the dose may be important in producing malignant change. In children irradiated for thymic enlargement, or possibly for various benign lesions in the head and neck, there is increased incidence of other cancers, particularly cancer of the thyroid. This finding has not been established for a certainty in adults. (C.H.)

**12454 ORO-SP-127(p.51-8)**

Illinois. Univ., Chicago. [Coll. of Medicine].

**RADIATION CATARACTS IN ANIMALS.** D. V. L. Brown. 8p.

Accumulated data are reviewed from animal studies on the induction of cataracts by exposure of the eye to neutrons or x and gamma radiation. In the early stages ionizing radiation results in a characteristic clinical picture that differs from all other types of cataract. However, in very late stages the radiation cataract cannot be differentiated from other more common varieties such as senile cataract or the so-called complicated cataract following ocular infections. Mechanisms involved in cataract production are discussed. An effort is made to clarify the cataractogenic threshold dose for man. (C.H.)

**12455 ORO-SP-127(p.59-70)**

Harvard Univ., Boston. Howe Lab. of Ophthalmology.

**RADIATION CATARACTS IN MAN.** David G. Cogan. 12p.

The occurrence of cataracts in man has occupied a conspicuous place in discussions of ionizing irradiation because of the incapacity that results from the visual loss. Opacification of the lens substance results in loss of useful visual functions, whereas opacification of other tissues would be of such little consequence that it would go unnoticed. The fact that lens cells are encased in a capsule which prevents exchange at the cellular level may contribute to the irreversibility of cataracts or to the failure in effective repair of the damaged lens. Available data are reviewed on the pathogenesis of radiation cataracts and an attempt is made to establish the amount of radiation necessary for cataract induction in man. (C.H.)

**12456 ORO-SP-127(p.73-9)**

Division of Biology and Medicine, AEC.

**GENETIC ALTERATIONS IN ANIMALS AND MAN.**

Douglas Grahn. 7p.

It is extremely difficult to discuss the problems of radiation genetics in man since there is so little direct data from human studies. Controlled mating systems must be employed in order to evaluate the genetic effects of radiation quantitatively, and this obviously is impossible in human studies. The types and numbers of known mutations in man are discussed. Results of animal studies are reviewed in order to evaluate the genetic effects of radiation. Tabulated data are included on the radiation-induced mutation rate in mice. Factors affecting mutation induction are discussed. It is pointed out that man's environment is extremely variable and it is difficult to make extensive observations on human populations. (C.H.)

**12457**

**QUANTITATIVE MEASUREMENTS OF OXYGEN TENSION IN NORMAL TISSUES AND IN THE TUMOURS OF PATIENTS BEFORE AND AFTER RADIOTHERAPY.**

Donald B. Cater and Ian A. Silver (Univ. of Cambridge, Eng.). *Acta Radiol.* 53, 233-56(1960) Mar.

Quantitative measurements of oxygen tension in tumors and normal tissues of patients were made by the oxygen



cathode technique before and after radiotherapy. Statistical analysis showed that log oxygen tension has a normal distribution. The ratio (tissue oxygen tension when breathing oxygen/tissue oxygen tension when breathing air) = K, a constant of mean value 2.1 to 2.3 for muscle, subcutaneous tissue, tissues near tumor, and tumor before treatment. After radiotherapy, K is significantly higher for tumor, but for no other tissue. The effect of the radiosensitizer Synkavit on the oxygen tension is described. Warming by diathermy reduced tumor oxygen tension and the response to breathing oxygen. The findings encourage use of oxygen inhaled at atmospheric pressure as a radiosensitizer, but patients require 7 to 8 l/min for 30 min, to obtain maximum tumor oxygen tension. (auth)

#### 12458

CHROMATOGRAPHY OF THE PHOSPHOLIPIDES OF RABBIT SKIN. H. P. Schwarz, L. Dreisbach, R. Stam-  
baugh, A. Kleschick, and M. Barrionuevo (Philadelphia  
General Hospital). Arch. Biochem. Biophys. **87**, 171-8  
(1960) Apr.

Mixed lipides of the skin of rabbits have been used for the separation of their phospholipide components on a silicic acid column. Through use of a gradient elution with a number of chloroform-methanol mixtures and pure methanol, satisfactory separations have been obtained in an 8-hr period. The elution patterns have been constant and the phosphorus recoveries have been high (91%). Combined chemical, infrared, and paper chromatographic techniques have been used for analysis. Lecithin, phosphatidylethanolamine, and phosphatidylserine comprise the major phospholipide components. Polyglycerolphosphatides, lysolecithin, and sphingomyelin occur in sufficient quantity to be of interest. Small amounts of plasmalogens and traces of two unidentified lipides, one of which appears to be a lysocephalin, make up the rest of the skin phosphatides. (auth)

#### 12459

EFFECT OF IONIZING RADIATION ON THE PROTEIN METABOLISM OF FISH. Ya. A. Epshtein and N. F. Lavroskaya (All-Union Scientific Research Inst. of Lake and River Fish Husbandry, Leningrad). Biochemistry (U.S.S.R.) (English Translation) **24**, 549-55(1959) July-Aug.

Radioactive isotopes, which may be present as contaminants in the waters of reservoirs, may be accumulated by fish, and retained by them for long periods of time. Some importance hence attaches to the study of the sensitivity of fish to radiation, and of the effects of radiation on them. The present research is devoted to these subjects. (auth)

#### 12460

THE EFFECT OF IONIZING RADIATION ON THE ACTIVITY OF BONE-MARROW NUCLEIC ACID DEPOLYMERASES. R. E. Libinon. Biochemistry (U.S.S.R.) (English Translation) **24**, 625-9(1959) July-Aug.

Beginning with the work carried out under the direction of Hevesy it has become well known that ionizing radiation causes a great change in quantity and metabolism of the nucleic acids of mammalian tissue. It showed in earlier studies that the amount of desoxyribonucleic acid (DNA) and ribonucleic acid (RNA) of bone marrow decreases sharply in the first hour after a single strong irradiation (dose 1000 r). It is difficult to explain this fall in amount of nucleic acids only by the inhibition of the synthesis of these compounds. It has been suggested that the observed fall in content of DNA and RNA is the result of the action of two opposing processes: a decrease in synthesis of the nucleic acids and an increase in their splitting. To test this idea the authors undertook to study

nucleic acid depolymerase activity in bone marrow as the enzyme which first determines the splitting. (auth)

#### 12461

ANTIBODY SYNTHESIS AND THE RATIO OF PROTEIN FRACTIONS IN BLOOD SERUM UNDER THE INFLUENCE OF IONIZING RADIATION. L. G. Prokopenko (Kursk State Medical Inst., USSR). Biochemistry (U.S.S.R.) (English Translation) **24**, 643-9(1959) July-Aug.

The study of immunogenesis in radiation sickness has become important in recent years. Interest in this question is aroused because ionizing radiation, which destroys the natural protective mechanisms, may permit the development of infectious diseases which are often disastrous to the irradiated animal. Therefore, the study of the mechanism of inhibition of antibody production after irradiation becomes very valuable. The opinion exists that the synthesis of antibodies and some protein fractions of the blood occurs in the same cells of the reticuloendothelial system. A number of investigators consider the formation of antibodies as a modification of the synthesis of blood  $\gamma$ -globulin in the presence of the antigen, since the antibody and the  $\gamma$ -globulin are very similar in chemical and physicochemical properties such as the order of arrangement of amino acids, electrophoretic mobility, isoelectric point, etc. Immunization of animals by different antigens causes proliferation of the cells of the reticuloendothelial system and transformation of the lymphocytes into plasmatic cells; a number of authors consider this of major significance in the synthesis of specific and nonspecific blood globulins. This results from the repeatedly observed parallel increase in amount of globulins and titer of antibodies in immune animals. The effect of penetrating radiation on the ratio of protein fractions of blood serum has not been sufficiently studied. The literature contains only a few, contradictory results on this question. No work was found on the study of the combined action on antibody production and production of different protein fractions by two factors so antagonistic in antibody synthesis as immunization and penetrating radiation. It is therefore felt that it is not without interest to compare the dynamics of change in the synthesis of different antibodies and the ratio of protein fractions of blood serum. (auth)

#### 12462

THE INHIBITING EFFECT OF SUBSTANCES FORMED IN IRRADIATED PLANTS ON THE CELL DIVISION GROWTH AND DEVELOPMENT OF UNIRRADIATED PLANTS.

A. M. Kuzin, L. M. Kriukova, G. N. Saenko, and V. A. Iazykova (Inst. of Biological Phys., Academy of Sciences, Moscow). Biophysica (U.S.S.R.) (English Translation) **4**, No. 3, 104-8(1959).

Water soluble substances were extracted from the tissues of irradiated and unirradiated plants. It has been shown that the substances extracted from irradiated plants inhibited the growth and development of seedlings by 22 to 30 per cent and mitotic activity by 38 per cent. (auth)

#### 12463

COMPARATIVE STUDY OF THE EFFECTS OF DIFFERENT RADIATIONS ON THREE SPECIES OF PLANTS.

André Gilles (Institut Interuniversitaire des Sciences Nucleaires, Brussels). Bull. Classe sci., Acad. roy Belg. (5), **45**, 909-12(1959). (In French)

The first results are given from a series of studies on the effects of x rays, neutrons, and gamma rays on Solanum acaule, Arachis hypogaea, and Oryza sativa. The radiosensitivity of such plants exposed to three radiations varies. For each of the three plants studied there

was a variation with each of the three radiations. These conclusions are brought out in a comparative table, and the various reactions expressed in three degrees of sensitivity. The optimum doses for each case show up clearly in the comparisons. (tr-auth)

#### 12464

THE EFFECT OF GAMMA RADIATION ON AQUEOUS AND ALCOHOLIC WHEAT FLOUR EXTRACTS. A. R. Deschreider. Bull. école meunerie belge 20, No. 4, 48-53 (1958). (In French)

The action of  $\gamma$  rays on aqueous and alcoholic extracts from baking flour showed not only organoleptic changes but also chemical changes in the sugar and protein content. These changes were studied by using a certain amount of flour suspended in 10 times its weight of distilled water and subjected to ultra-centrifugation. The clear supernatant solution was irradiated in the Belgian reactor BR-1 at Mol. The applied dosages were  $1.5 \times 10^5$ ,  $3 \times 10^5$ ,  $6 \times 10^5$ , and  $9 \times 10^5$  rads. Flocculation started at 300,000 rads with the formation of the amino acids which form the brown pigment of bread crust. The action on proteins was stronger in aqueous solution than in alcoholic solutions, although in the latter the aldehyde formation was more pronounced depending on the dose applied. It was noted that certain nitrogenous components of wheat that are soluble in water become insoluble when  $\gamma$ -irradiated because of the increase in the length of the protein chains which in turn may improve the colloidal qualities of wheat flour or other wheat products. (OID)

#### 12465

THE INFLUENCE OF IONIZING RADIATION ON THE BAKING QUALITY OF WHEAT. E. Maes. Bull. école meunerie belge 20, No. 5, 60-5 (1958). (In French)

The irradiation of wheat or wheat flour with ionizing rays causes a polymerization of the proteins so that their chain length is lengthened and the interchain bridges increase the complexity of their structure. These changes might cause alterations in the baking quality which could be favorable or harmful to the baked products. The effects of ionizing radiation were studied by using 7 samples of Belgian commercial domestic wheat which had been packed in quantities of 400 g in polyethylene bags and sent to the reactor in Mol. They were placed in Al containers and irradiated with 120 to 800 krad from spent U bars. After irradiation, the samples were tested with the alveograph, the farinograph, the neo-laborograph and in actual baking tests. Results showed that the quality of wheat and wheat flour could be greatly improved by ionizing radiation. The only disadvantage is that the bread crumb is a somewhat darker color. Wheat irradiation seems economically possible because sufficient atomic waste products are available. Animal and human tests showed no indications of residual radioactivity or any toxicity of the baked products made from irradiated wheat or wheat flour. (OID)

#### 12466

THE DETERMINATION OF THE SENSITIVITY TO THE TUMORIGENIC EFFECT OF X RAYS IN DROSOPHILA MELANOGASTER MEIG. Sabbas Ghelelovitch. Compt. rend. 250, 1387-8 (1960) Feb. 15. (In French)

The irradiation formation of melanotic tumors depends, in the *Drosophila*, on the hereditary constitution of the individuals irradiated. However, the sensitivity to the tumorigenic effect of x rays can not be attributed exclusively to the presence in the geno-type of a "tumor gene" responsible for the hereditary predisposition to spontaneous tumorigenesis. (tr-auth)

#### 12467

EFFECT OF X RAYS ON THE GROWTH OF CULTURES OF UNICELLULAR CHLOROPHYLL ORGANISM: Scenedesmus crassus CHOD. (CHLOROPHYLL ALGA). Roland Gilet and Paul Ozenda (Centre d'Étude Nucléaires, Grenoble, France). Compt. rend. 250, 1552-4 (1960) Feb. 22. (In French)

The effect of x radiation on the growth of Scenedesmus crassus Chod. was studied. The alga was living isolated or in coenobia with two to four individuals. The culture conditions are described. The cultures were irradiated in normally aerated media with a single dose. A schematic representation of the results of 15 experiments is given. After irradiation with 5000 r, the rate of growth of the alga is increased but not in a statistically significant manner. Between 5000 and 20,000 r, the rate of growth is less than that of the samples. From 25,000 to 35,000 r the growth continues for some days after irradiation then it ceases. Doses above 30,000 r result in identical growth curves. (J.S.R.)

#### 12468

DECREASE OF THE CUTANEOUS RADIOSENSITIVITY OF THE RAT BY ANTIHYALURONIDASE SERUM. Jean Loiseleur and Michelle Petit. Compt. rend. 250, 1578-9 (1960) Feb. 22. (In French)

It is possible to cause, by serotherapeutic method, a modification of the radiosensitivity. The serum antihyaluronidase, which slows the metabolism of connective tissue, decreases the cutaneous radiosensitivity of the rat. (tr-auth)

#### 12469

THE RESULTS OF EXPERIMENTS OF TRANSVERSE RADIODESTRUCTION APPLIED TO THE CHICKEN EMBRYO. Nicole Le Douarin (Collège de France, Paris and Centre National de la Recherche Scientifique, Paris). Compt. rend. 250, 2064-6 (1960) Mar. 14. (In French)

Chicken embryos exposed at the beginning of their development to the localized radiodestruction of an extended region can continue their evolution if the extra-embryonic circulation, then allantois, can be established. The parts of the embryo not exposed are joined to each other and tend to develop according to normal morphogenesis. In addition it is seen that it is possible to map the rudimentary digestive tract. (J.S.R.)

#### 12470

THE EFFECT OF RADIATION ON FOODS. I. PHYSICAL FOUNDATION OF FOOD IRRADIATION. Hans Lück and Hermann Kühn. Deut. Lebensm.-Rundschau 55, No. 2, 37-45 (1959). (In German)

After a very elementary discussion of the physical character of corpuscular and electromagnetic radiation and their effect on foods and microorganisms, an installation for the irradiation of foods on an industrial scale is described. One of the greatest economic advantages of irradiation over thermal preservation is the better utilization of energy. To heat 1 kg of food from 20° to 100°C and keep it at this temperature until complete sterilization is achieved requires about 10 to 15 times more energy than is necessary to achieve sterilization by  $\gamma$  radiation. The accompanying rise in temperature of 4°C is negligible, and thus heat induced changes in foods are eliminated. The costs of radiation sources of high intensity and the operating costs of the radiation installation are decisive for the economy of industrial radiation preservation of food. In this respect x rays are more expensive than  $\gamma$  rays, especially  $\text{Co}^{60}$  and  $\text{Cs}^{137}$  which originate as reactor by-



products.  $\beta$  emitters and the operation of electron accelerators also involve great expenses, although the accelerator can be turned on and shut off according to the requirements. (OID)

#### 12471

DNA SYNTHESIS IN IRRADIATED INTESTINAL EPITHELIUM. F. G. Sherman and H. Quastler (Brown Univ., Providence and Brookhaven National Lab., Upton, N. Y.). *Exptl. Cell Research* 19, 343-60(1960) Mar.

DNA synthesis in the intestinal epithelium of X-irradiated mice was studied by means of autoradiography following labeling with tritiated thymidine. Radiation doses used varied from 200 to 3000 rads whole-body irradiation. The label was administered once or 5 times, at times ranging from one day before to 3 days after irradiation. The time from irradiation to sacrifice varied from 0 to 3 days. Irradiation results in reduction of thymidine incorporation. The rapidity of development and the ultimate severity of this effect increase with dose. An analysis of possible mechanisms indicates that the initial phase of the effect observed is a block of DNA synthesis in cells in the DNA synthesis phase. The fate of cells irradiated while in DNA synthesis phase was studied. Some of them die, the majority mature precociously and emigrate into the region occupied by mature cells, and some remain in the zone of proliferation. After moderate to heavy doses, DNA synthesis is resumed long before cell division. In heavily irradiated mice, the remaining crypt cells go through one to two cycles of DNA synthesis not followed by division. The migration of mature cells along the villi is not markedly affected by irradiation. Emptying of the crypts occurs in heavily irradiated animals chiefly on the first and third day after irradiation, at times when there is no or little DNA synthesis. These observations, combined with the results of previous studies, shed some light on the mechanisms which control cell movements, particularly the transitions from crypts to villi. Qualitative and quantitative changes in the population of mature cells on the villi reflect the lack of cell proliferation and changes of cell retention in the crypts. (auth)

#### 12472

A PILOT EXPERIMENT WITH MICE, USING HALDANE'S METHOD FOR DETECTING INDUCED AUTOSOMAL RECESSIVE LETHAL GENES. T. C. Carter (Medical Research Council's Radiobiological Research Unit, Harwell, Berks, Eng.). *J. Genet.* 56, 353-62(1959) Dec.

A search was made for x-ray-induced recessive autosomal lethal genes in the mouse, using a method proposed by J. B. S. Haldane, the experiment was intended primarily to test the method. It was found that the method is less efficient for measuring mutation rates than the specific-locus method. Data obtained enabled a lower limit to be set for the x-ray dose required to induce one recessive autosomal lethal in spermatogonia, namely 810 r. No upper limit could be set. Relevance to human problems is discussed. (auth)

#### 12473

EMBRYOLOGY OF THE LITTLE AND BAGG X-RAYED MOUSE STOCK. T. C. Carter (Medical Research Council's Radiobiological Research Unit, Harwell, Berks, Eng.). *J. Genet.* 56, 401-35(1959) Dec.

The morphology and development of the many defects in mice of the Little and Bagg x-rayed stock have been reinvestigated in an attempt to resolve the conflicts in the findings of earlier investigators. The observation that blebs occur on pseudencephalic embryos is incompatible with Bonnevie's hypothesis that they originate as cerebro-

spinal fluid in the myelencephalon; other observations support Plagens' hypothesis that the blebs originate as mesenchymal intercellular fluid. No unitary gene action was found. Four pedigrees of causes were constructed covering, respectively, defects of the central nervous system, bleb-induced lesions and defects of the body wall, morphological defects of the hind limbs, and defects of the urogenital system; there were cross-correlations between defects in the first three pedigrees, but the underlying mechanisms were not identified. (auth)

#### 12474

THE INDUCTION OF MUTATION WITH IONIZING RADIATION. C. Broertjes. *Landbouwk. Tijdschr.* 70, 303-12 (1958) May. (In Dutch)

Only recently have attempts been made to alter systematically the genotypes of plants by ionizing radiation because the margin between the lethal dose and the mutational dose is very small and different for most plants. Lethal doses are 800 r for beans, 10 to 12,000 r for peas, 20,000 r for barley, 50,000 r for flax, and 70 to 80,000 r for mustard; in general, mutational doses lie between 20,000 and 25,000 r. Mutational studies were carried out on agricultural and horticultural plants in order to find higher yielding or insect and disease resistant mutants or mutants with other desirable properties. (OID)

#### 12475

SOME DATA ON THE MECHANISM OF RADIATION AFFECTION OF HEMATOPOIESIS. M. S. Lapteva-Popova and Yu. V. Venitskovskii-Zolotykh. *Med. Radiol.* 5, No. 2, 3-12(1960) Feb. (In Russian)

The mechanism of radiation affection of the blood system in radiation sickness was investigated using a lead screen for protection of a portion of hematopoietic tissue at the time of whole-body x-ray irradiation. Experiments were staged on 208 white rats divided into three groups. The dose of irradiation was 500 r. A portion of the bone marrow was screened in the animals of the first and second group. The control rats were subject to irradiation without any protection. In the animals of the third group, the spleen was mobilized through an incisure in the abdominal wall and protected. The control rats of this group were subject to an abdominal wall incisure before the irradiation. All animals of the third group underwent irradiation under ether anesthesia. The peripheral blood and hematopoietic organs were investigated before the experiment and on the 1st, 3rd, 5th, 10th, 12th, and 20th day after the irradiation. The results show that protection of a portion of bone marrow or spleen was inductive to a larger survival rate of the experimental animals and effected a more rapid and complete regeneration of the blood. Screening was found to diminish the primary affection of the protected portion of hematopoietic tissue. Certain pathological processes characteristic for radiation injury developed at a later time. The principal link in radiation affection of hematopoiesis was found to be the disturbed ability of polypotent reticular cells of hematopoietic organs to differentiate and pass into the blood cells. Protective screening produced a retention of early stages of hematopoiesis (absence of inhibition during the passing of reticular cells into the blood cells). (auth)

#### 12476

DATA ON THE ANALYSIS OF LEUKOCYTIC REACTION CHANGES IN RESPONSE TO STIMULATION OF GASTRIC MECHANORECEPTORS IN ANIMALS AFTER IRRADIATION. T. V. Tkacheva. *Med. Radiol.* 5, No. 2, 12-18(1960) Feb. (In Russian)

Data are presented on the leukocytic reaction to different

stimuli in animals (stimulation of gastric mechanoreceptors and intramuscular injection of milk) after irradiation (300 and 550 r). An attempt was made to elucidate the mechanism of these changes. The receptors were irritated by the inflation of a rubber balloon (30 mm Hg) which was introduced into the stomach through a fistula. After the irradiation, as well as during the subsequent restoration of the initial level of leukocytes, an absence or perversion of the leukocytic reaction to the stimuli employed was observed. The reaction to stimulation was restored 12 to 16 months afterwards. (auth)

#### 12477

THE EFFECT OF CYSTEINE AND  $\beta$ -MERCAPTOETHYLAMINE ON THE VENOUS OXYGEN CONTENT IN RATS. E. F. Romantsev. *Med. Radiol.* 5, No. 2, 19-21(1960) Feb. (In Russian)

The mechanism of the protective effect of compounds which are able to protect animals against the lethal doses of ionizing radiation was studied. It was demonstrated that administration of L-cysteine to rats provoked a reduction of the venous oxygen content in 15 to 25 minutes after the injection. This decrease was preserved in the process of irradiating the animals with the lethal dose of  $\gamma$  rays (650 r).  $\beta$ -mercaptoethylamine administration produced a decrease of the venous oxygen content which occurred at a later date. (auth)

#### 12478

ROENTGENOLOGICAL OBSERVATIONS OF IRRADIATED ANIMALS WITH EXPERIMENTAL FRIEDLÄNDER PNEUMONIA. R. M. Rabinovich. *Med. Radiol.* 5, No. 2, 22-5 (1960) Feb. (In Russian)

The development and course of inflammatory processes due to Friedländer pneumonia in the lungs of 13 dogs irradiated with sublethal doses of x rays were studied. In the irradiated dogs infected with Friedländer's bacillus pneumonia becomes manifest at the early stages of development. A dynamic x-ray investigation aided in elucidating the nature of lobar lesions in the irradiated and infected dogs. The cause of the varying clinical course of pneumonia in irradiated and nonirradiated dogs is discussed. (auth)

#### 12479

THE INFLUENCE OF REPEATED INJECTIONS OF DISTILLED WATER ON THE COURSE OF ACUTE RADIATION SICKNESS IN DOGS. N. N. Klemparskaya and N. V. Raeva. *Med. Radiol.* 5, No. 2, 26-30(1960) Feb. (In Russian)

An attempt was made to influence the course of acute radiation sickness by multifold formation of tissue decomposition products in the skin following injections of distilled water before and after irradiation. The experiments were performed on 42 dogs irradiated with a lethal dose of gamma-rays. It was found possible to attain, in healthy dogs, a rise of body sensitivity to products of tissue decomposition after repeated injections into the skin of 0.5 ml of sterile distilled water, provided the number and sites of injections were observed. This change did not exert an essential influence on the course of acute radiation sickness during the subsequent irradiation of these dogs. It was found that injections of distilled water, after the irradiation, may aggravate the course of radiation sickness and reduce the life span of the animals by 2 to 3 times if they were effected into the zones of elevated allergic sensitivity of the organism, such as the skin of the upper lip. Injections of distilled water into the skin of the abdomen did not exert such an action. (auth)

#### 12480

THE INFLUENCE OF PROTECTIVE SUBSTANCES ON

THE LEVEL OF NUCLEIC ACIDS IN ORGANS FOLLOWING IRRADIATION. D. Milich and Ya. Nosek. *Med. Radiol.* 5, No. 2, 31-3(1960) Feb. (In Russian)

On the basis of changes of ribonucleic acid and deoxyribonucleic acid content in the liver and spleen of irradiated animals, the protective action of various substances against the action of penetrating radiation was assessed. Cysteamine and cyanhydrin of methylethylketone were found to be endowed with a considerable protective action. Thiocholesterin exhibited a weaker protective effect in comparison with cysteamine and cyanhydrin. The protective substances exerted an action similar to that obtained when the liver and spleen are protected by a lead screen, but to a considerably weaker degree. (auth)

#### 12481

LABOUR CONDITIONS IN CORING WITH NEUTRON SOURCES. V. I. Prostyakova, R. S. Belova, and I. I. Yankovskii. *Med. Radiol.* 5, No. 2, 62-6(1960) Feb. (In Russian)

In bore-hole logging, the polonium and beryllium sources of fast neutrons with an energy equaling several curies were used. The magnitudes of neutron fluxes acting upon the operators under total exposition was below the maximal permissible limits but in local irradiation of hands the magnitudes exceeded the permissible value 6 times. Considering the accompanying gamma-irradiation which takes place at this instance, an unfavorable biological effect upon the operators may be expected. To assess the probable biological effect of such an irradiation an experimental investigation was performed in connection with the study of the action of equivalent fluxes of fast neutrons upon animal organism. Twenty series of irradiation in doses, equivalent with that permissible for man, provoked in white rats a retardation in the general development, disturbance of the generative function, changes in the composition of the peripheral blood, and appearance of induced radioactivity. (auth)

#### 12482

THE INFLUENCE OF RADIATION ON RECOVERY.

James B. Hartgering (Walter Reed Army Medical Center, Washington, D. C.). *Military Med.* 123, 210-15(1958) Sept.

The radiation component of nuclear weapons introduces a new type of injury with which there has been no previous battlefield experience. All recent operations analyses have emphasized that ionizing radiation will be the most important primary and complicating cause of military casualties in the event of nuclear war. Some of the implications of radiation on the clinical course and medical management of familiar injuries and diseases are discussed. The need is stressed for research on the clinical aspects of the combined effects of radiation and injury. The interest of the military in time of war will not be in whether or not the combination reacts synergistically with doubling or tripling sensitivity, but how these effects can be modified to protect more individuals and return more men rapidly to the combat command. (C.H.)

#### 12483

SYNTHESIS OF CONTRACTILE PROTEINS IN THE X-IRRADIATED EMBRYO. Yoshito Ogawa (National Inst. of Genetics, Misima, Shizuoka-ken, Japan). *Nature* 186, 77-8(1960) Apr. 2.

The synthesis of contractile proteins in x-irradiated embryos of *Triturus pyrrhogaster* was examined by a serological technique. The time of actin and myosin formation after fertilization was measured for x-ray doses of 50, 200, and 500 r. X-irradiation 108 hr after fertilization markedly suppressed the synthesis of actin



and promoted that of myosin in the early developmental stages. It is concluded that the formation of actin did not induce that of myosin and the processes of synthesis of those proteins are independent of each other. (C.J.G.)

**12404**

SIGNIFICANCE OF ADRENALS FOR INCREASED OXYGEN CONSUMPTION IN RATS DURING IRRADIATION. A. Vacek (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). *Nature* 186, 90-1(1960) Apr. 2.

In studies on adrenalectomized rats, the oxygen consumption increased during irradiation. Mechanisms of this change are discussed. (C.J.G.)

**12405**

HAZARD OF TRITIUM AS A DEOXYRIBONUCLEIC ACID LABEL IN MAN. R. Oliver and L. G. Lajtha (Churchill Hospital, Oxford). *Nature* 186, 91-2(1960) Apr. 2.

The main hazard of using tritiated desoxyribonucleic acid precursors is shown to be the mutagenic effects produced in those cells which have a long life span and several mitotic cycles in the body. (C.J.G.)

**12486**

EFFECT OF S- $\beta$ -AMINOETHYLISOTHIURONIUM BROMIDE HYDROBROMIDE ON X-RAY DAMAGE TO GUINEA PIG SKIN. J. B. Walter and D. Slome (Royal Coll. of Surgeons, Dublin). *Nature* 186, 177(1960) Apr. 9.

When administered before exposure, S- $\beta$ -aminoethylisothiuronium bromide hydrobromide protected the skin of guinea pigs and rats against damage from x radiation. (C.H.)

**12487**

DIVERGENCE BETWEEN LETHAL DOSES AND STERILIZING DOSES OF X-RAYS WITH PROGRESSIVE DEVELOPMENT IN HABROBRACON FEMALES. Howard E. Erdman (General Electric Co., Richland, Wash.). *Nature* 186, 254-5(1960) Apr. 16.

The weakest link in an insect life-cycle was determined and related to the quantitative differences between the sterility and lethality doses when virgin females were irradiated at various developmental stages. Data are presented on Habrobracon. (C.H.)

**12488**

CHANGES IN STRUCTURE OF A PERICLINAL CHROMOSOMAL CHIMERA OF APPLE FOLLOWING X-IRRADIATION. Charlotte Pratt (N. Y. State Agricultural Experiment Station, Geneva). *Nature* 186, 255-6(1960) Apr. 16.

The effects of x radiation on a 2-2-4-4 chimera of the Giant Spy apple are described in detail. Applications in breeding polyploid apples are suggested. (C.H.)

**12489**

DURATION OF THE EFFECT OF  $\beta$ -AMINOETHYLISOTHIURONIUM CHLORIDE HYDROCHLORIDE IN THE AREA OF LOW RADIATION DOSES. H. Langendorff and M. Langendorff (Universität, Freiburg i.B.). *Naturwissenschaften* 47, 111-12(1960) Mar. 1. (In German)

The duration of the protective effect of  $\beta$ -aminoethylisothiuronium chloride hydrochloride was investigated for radiation doses corresponding to an LD<sub>50</sub> in the controls. Male mice received AET at different time intervals before whole-body irradiation with 590 r. The percentage of animals living 30 days after the irradiation is tabulated. The percentage of animals surviving after oral administration of AET up to six hours before the irradiation is between 80 and 90%. (J.S.R.)

**12490**

ANNUAL VARIATION OF THE RADIOSENSITIVITY OF

BARLEY. F. Barnetzky (Deutsche Akademie der Wissenschaften, Berlin und Institut für Kulturpflanzenforschung, Gatersleben, Ger.). *Naturwissenschaften* 47, 116-17(1960) Mar. 1. (In German)

Observations made under standardized conditions over a period of three years showed an annual radiation sensitivity in barley. Each week 100 seeds of summer barley "Haisa," stored under no special conditions, were exposed to hard radiation at doses of 15, 16, 17, 18, 19, and 20 kr. The seeds were planted under greenhouse conditions. The number of plants living after six weeks was the measure of the radiation effects. The results for seeds exposed to 15 kr are graphed and show that in summer from 70 to 40% of the plants survive, according to the age of the seed, and in winter the survival rate falls almost to zero. At higher doses the survival rate is lower, but the variation between summer and winter planting is still evident. (J.S.R.)

**12491**

COMPLEMENTARY EFFECTS OF HEAT AND RADIATION ON FOOD MICROORGANISMS. Lloyd L. Kempe (Univ. of Michigan, Ann Arbor). *Nucleonics* 18, No. 4, 108; 110; 112-13(1960) Apr.

Heat and radiation used together may be more effective for food preservation than either one alone. Each of these agents can be somewhat damaging: overcooking food sometimes reduces its nutritive value; radiation can produce off-odors, off-flavors, and degraded textures. Experiments show that a radiation dose that is about one third of the sterilization dose reduces the heat treatment required to sterilize to about one fourth of what it is without radiation. Consider, for example, a canned beef. Heat enough to sterilize the center may overcook the outside. Radiation enough to sterilize it produces off-flavors. But one can hope to use a comparatively small radiation dose and then sterilize the beef with an amount of heat too small to overcook. (auth)

**12492**

UROROSEIN AND INDOLACETIC ACID IN NORMAL RATS AND AFTER IRRADIATION WITH X-RAYS. V. Holeček. *Pracovní lékařství* 11, 442-5(1959) Nov. (In Czech.)

The total amount of uroresoin and its components was determined, including indolacetic acid, in normal rats. It was found that the normal rat urine contains in 24 hours an average of  $300 \pm 71 \mu\text{g}$  of total uroresoin (14 rats were investigated for an average period of 15 days) and an average of indolacetic acid of  $130 \pm 42 \mu\text{g}$  (8 rats were investigated on an average of 18 days). After irradiation with x rays with a dose approaching LD<sub>50</sub>, the amount of uroresoin and its components remained in the range of normal values. In some instances a color change of uroresoin occurred which manifested itself by a shift of the maximum optic absorption to shorter or longer wave lengths, depending perhaps on the individual properties of the rat. The color change cannot be used for a diagnostic test. (auth)

**12493**

CHANGES IN HEMOPOIESIS IN PATIENTS WITH THYROTOXICOSIS UNDER TREATMENT WITH RADIOACTIVE IODINE. D. D. Kafafova (Central Postgraduate Medical Inst., USSR). *Problems Hematol. Blood Transfusion* (U.S.S.R.) (English Translation) 4, No. 8, 26-33(1959).

The most characteristic changes in the blood of patients with thyrotoxicosis are leukopenia with a relative lymphocytosis or monocytosis, and in severe forms of the disease anemia of hypochromic type. After administration of 2 to 11 mc of iodine-131 a slight depression of leukopoiesis

is observed, with a plasma cell and reticulum cell reaction. The white cell count of the peripheral blood falls temporarily and is restored to the initial level after 2 months. Return to normal of the white cell count with an initial leukopenia begins after disappearance or considerable alleviation of the signs of the thyrotoxicosis after 3 to 8 months. No disturbance of erythropoiesis nor thrombocytopoiesis is observed. The thrombocytopenia which sometimes is present is not accompanied by hemorrhages. The functional changes in the blood are transient in character. An initial leukopenia is no contraindication to iodine-131 treatment of thyrotoxicosis. The fluorescent method of microscopy enables histochemical changes to be detected in the blood cells much sooner than by the usual morphological methods. (auth)

#### 12494

INFLUENCE OF RADIOACTIVE COLLOIDAL GOLD ON EHRlich ASCITES TUMOUR. S. M. Volodarskaya (Volodarskaya) (First Moscow Medical Inst. (Order of Lenin)). Problems of Oncol. (U.S.S.R.) (English Translation) 5, No. 4, 40-44(1959).

Radioactive colloidal gold, with an activity of 0.05 mc, administered intraperitoneally to mice with Ehrlich ascites tumor inhibited the development of ascitic fluid but did not prolong the life of the animals. This dose caused radiation sickness which led to the death of the animals. (C.H.)

#### 12495

ON THE BLASTOMOGENIC ACTION OF CERium ( $^{144}\text{Ce}$ ). Yu. (Iu.) I. Moskalev and V. N. Strel'tsova (Academy of Medical Sciences, Moscow). Problems of Oncol. (U.S.S.R.) (English Translation) 5, No. 6, 33-40(1959).

Osteosarcoma, leucosis, and tumors of the hypophysis, adrenals, thyroid gland, gastro-intestinal tract, liver, kidneys, ovaries, and other tissue appeared in rats after the injection of  $\text{Ce}^{144}$ . Tumors of the bones, liver, kidneys, and hematopoietic tissue predominated after the injection of 0.8 to 0.25  $\mu\text{c/g}$  of  $\text{Ce}^{144}$ ; smaller quantities of  $\text{Ce}^{144}$  gave rise to neoplasm of the endocrine glands. The incidence of osteosarcoma and the rapidity with which it appeared varied in proportion to the quantity of  $\text{Ce}^{144}$  injected. The optimum radiation dose for osteosarcoma is ~50 krad, the minimum is 2.1 krad. Osteosarcoma develops rather more frequently in males. Neoplasms of the endocrine glands are more common in females. (auth)

#### 12496

OSTEOGENIC SARCOMATA IN DOGS AFFECTED BY  $\text{Sr}^{90}$ . N. N. Litvinov (Academy of Medical Sciences, Moscow). Problems of Oncol. (U.S.S.R.) (English Translation) 5, No. 6, 40-47(1959).

Of 16 dogs affected by  $\text{Sr}^{90}$  in doses causing a chronic radiation disease, malignant tumors of the bone system of various histological structures developed in 4, including multiple tumors in 2 dogs. The tumors were noticed 610, 620, 880, and 935 days after the introduction of the radioactive substance. In 3 dogs the tumors arose in the area of the metaphysis of the long, tubular bones—humerus, radius, tibia, and fibula. In 1 dog a tumor developed in the parietal bone. In the 4 animals under investigation, in sum, 8 tumorous nodes were found, 5 of which had an osteoplastic, 1 a mixed and 2 a lithic growth character. The tumors had a histological structure characteristic of osteogenic sarcomata. (auth)

#### 12497

RED AND FAR-RED ACTION ON OXIDATIVE PHOSPHORYLATION. Solon A. Gordon and Kenneth Surrey (Ar-

gonne National Lab., Lemont, Ill.). Radiation Research 12, 325-39(1960) Apr.

The rate of oxidative phosphorylation by isolated mitochondria was found to be affected by red (650 m $\mu$ ) and far-red (725 m $\mu$ ) light. Esterification of adenosine diphosphate to adenosine triphosphate by rat liver mitochondria is decreased by concomitant or prior irradiation with far-red and increased by red light. The effect of far-red is reversible by red in an alternating sequence. An analogous sensitivity was not found when isolated mitochondria of the Avena seedling were irradiated. However, irradiation of the intact seedling significantly affected the phosphorylative capacity of the mitochondria subsequently isolated. Whether enhancement or inhibition of activity took place depended on the time at which the seedlings were irradiated in the post germinative period. There is apparently no direct correlation between radiation-induced changes in phosphorylative rate and either mitochondrial protein or volume. Impairment of ATP generation is suggested as the biochemical basis for the far-red potentiation of x-ray-induced chromatid aberrations. The photosensitivity of this phosphorylation also suggests its consideration as a metabolic determinant of the photomorphogeneses controlled by red and far-red light. (auth)

#### 12498

SEARCH FOR IMMEDIATE EFFECTS OF X-RADIATION ON FROG NERVE-MUSCLE PREPARATIONS. D. Rosen and K. B. Dawson (Royal Cancer Hospital, London). Radiation Research 12, 357-70(1960) Apr.

A search was made for an effect of 140-kv x rays on the frog nerve-muscle preparation. The preparation was examined by stimulating the nerve electrically and recording the muscular response with a standard myograph and smoked drum. At the 50% level of significance doses of 10 kr had no effect, either during irradiation or within about 30 minutes of the end of it, on the muscular contraction or on the irritability, excitability, or latent or refractory periods of the preparation. Doses of 20 kr significantly decreased the amplitude of muscular contraction at the 10% level of significance, though not at the 5% level. By comparing these results with others published for isolated nerves and muscles, it is concluded that the presence of a neuromuscular junction may sensitize the preparation to the action of x rays by a factor of 2 to 3, but by not more than a factor of 5. It is suggested that such sensitizing factors from neuromuscular junctions and neural synapses may multiply up in an intact reflex arc. (auth)

#### 12499

THE EFFECT OF X-IRRADIATION ON THE PHOSPHOLIPASE AND ANTIOXIDANT ACTIVITIES OF RAT INTES-TINAL MUCOSA. Athos Ottolenghi and Frederick Bernheim (Duke Univ., Durham, N. C.). Radiation Research 12, 371-80(1960) Apr.

The antioxidant effect of intestinal mucosa is the result of the liberation of free fatty acid from phospholipid by phospholipase. The fatty acid binds the iron and thus inhibits peroxidation of unsaturated lipids in the test system. The phospholipase and antioxidant activity of rat intestinal mucosa decreases markedly 24 hours post-irradiation and to approximately the same extent. (auth)

#### 12500

THE RELATIVE BIOLOGICAL EFFECT OF VARIOUS QUALITIES OF X-RAYS ON GROWTH OF ASCITES TUMOR CELLS. Norman A. Baily and Ruth A. Brother (Roswell Park Memorial Inst., Buffalo). Radiation Research 12, 389-97(1960) Apr.

The RBE of x-ray beams of various quality, ranging in



half-value layers from 0.25 mm Al to 7.6 mm Pb, was determined by studying the inhibition of ascites tumor cell growth in Swiss mice. In this biological system, no significant difference in RBE was detected over the range of x-ray qualities used. (auth)

## 12501

THE FACTORS AFFECTING THE REACTIONS OF ANIMALS EXPOSED TO A NON-FRACTIONATED WHOLE-BODY IRRADIATION. R. Ghys and J. M. Loisselle (Université, Laval, Que.). *Rev. can. biol.* **19**, 53-79(1960) Apr. (In French)

Biological and physical functions of importance for total body irradiation are reviewed. In mammals radiosensitivity varies from species to species, but within narrow limits; it also varies with age. Strain and sex have little influence. Linear energy transfer (LET) along the track of the particles is a very important factor, but is almost impossible to measure "in vivo." The importance of the fractionation and of the output of the radiation is still under investigation. If 200 kv x rays are taken as reference, all ionizing radiations up to an energy of 30 Mev have a relative biological effectiveness (RBE) between 0.5 and 1. On the contrary, the R.B.E. of neutrons is generally equal to 2 to 3, or even more. The survival time is markedly shorter after a lethal dose of neutrons than after an equivalent dose of x or gamma rays. Death results from metabolic disturbances quantitatively different in the various organs. The radiation syndrome can be modified by physical, tissular, or pharmacological agents. Radiosensitivity is directly proportional to the  $O_2$  partial pressure at the level of the sensitive organ. Lead shielding on hematopoietic tissue during radiation exposure favors a more rapid recovery of the hematopoietic system and consequently prolongs the survival of the animal. Cellular therapy has a comparable effect. Most drugs which modify the effect of the irradiation belong to three large groups. Mercaptans increase the radioresistance of all organisms if they are injected immediately before the irradiation. Sex hormones act in mammals either as radioprotective or radiosensitizing agents, according to the sex of the recipient. This action lasts for several weeks after the injection and is qualitatively the same for ionizing radiations, neutrons, or radiometric drugs. Actinomycin D is an example of drugs of the third group, which act synergically to the irradiation. 120 references. (auth)

## 12502

HARMFUL EFFECTS OF IONISING RADIATIONS. Ethel Browning. Elsevier Monographs. Industrial Toxic Agents. New York, Elsevier Publishing Company, 1959. 167p.

The biological effects of ionizing radiation are reviewed. Emphasis is placed on those aspects of the problem of interest to industrial medical officers, safety officers, and workers engaged in the atomic energy industry. A complete subject index is included. (C.H.)

## 12503

RADIATION, GENES, AND MAN. Bruce Wallace and Th. Dobzhansky. New York, Henry Holt and Company, 1959. 212p.

Genetic effects of radiation on the human population of the world are postulated. Fundamentals of genetics and of radiation physics are reviewed. Deficiencies in our present knowledge are discussed and the need for research in the field of radiation genetics is stressed. (C.H.)

# Radiation Sickness

## 12504 JPRS-2269

ACUPUNCTURE AND TRADITIONAL MEDICINE IN THE

TREATMENT OF RADIATION REACTION. Hsien-chih Ku, Feng-ko Ch'in, and Li-chun Chang. Translated from *Chung Hua Fang Shē Hsüeh Tsa Chih* **7**, 379-83(1959). 27p. OTS.

A summary is presented of results obtained using acupuncture in the treatment of radiation reaction in patients receiving radiotherapy for malignant tumors. Of 292 patients treated, 90% are reported to have shown improvement while 50% were completely cured. Results of the treatment are analyzed according to the symptoms displayed by the patients. No description is included of the procedure used for acupuncture, although it is stated that research is needed to determine the most effective puncture sites. Results were disappointing in the treatment of 24 cases of nasopharyngeal carcinoma with acupuncture following irradiation. Data are included in results obtained in the treatment of radiation dermatitis with three traditional Chinese medicines. These include a mixture of egg white and Borneo camphor, a mixture of chicken egg yolk and fragrant oil, and an ointment prepared of a finely powdered mixture of rhubarb, Coptis Japonica, Phellodendron Amurense, and the leaves of lotus and of Coumarouna odorata mixed with lanolin base. All are reported to relieve skin reactions following radiotherapy. (C.H.)

## 12505 JPRS-L-875-N

CHEMOTHERAPY OF RADIATION SICKNESS IN MONKEYS UNDER EXPERIMENTAL CONDITIONS. M. A. Tumanyan and Z. V. Zhevtsova. Translated from *Med. Radiol.* **1**, No. 2, 41-5(1956). 10p. OTS.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 10, as abstract No. 9084. (C.H.)

## 12506

INFLUENCE OF IRRADIATION ON RESISTANCE TO INFECTION. Baruj Benacerraf (New York Univ. Coll. of Medicine, New York). *Bacteriol. Revs.* **24**, 35-40(1960) Mar.

Infection is a very frequent lethal complication of whole-body x radiation in the  $LD_{50}$  to  $LD_{100}$  range of dosage. Normal defenses against infection depend upon several factors, including the polymorphonuclear leucocytes, antibodies, bactericidal power of serum, and the reticulo-endothelial system. The effects of x-radiation damage on these mechanisms are discussed. The beneficial effect of spleen homogenates and spleen shielding and previous treatment with endotoxins in radiation induced infections are discussed. Possible reaction mechanisms involved are considered. 57 references. (C.H.)

## 12507

THE DISTRIBUTION OF LIPIDS IN THE CYTOPLASM OF LIVER CELLS IN ACUTE RADIATION SICKNESS. V. D. Blokhina and N. N. Demin. *Biochemistry (U.S.S.R.) (English Translation)* **24**, 663-7(1959) July-Aug.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 9623.

## 12508

THE ACTION OF SOME PREPARATIONS FROM THE ARALIA FAMILY IN EXPERIMENTAL RADIATION SICKNESS. I. I. Brekhan, L. I. Oskotskii, and A. I. Khakham. *Med. Radiol.* **5**, No. 2, 33-6(1960) Feb. (In Russian)

In ginseng therapy of irradiated mice (400 r), the survival was  $2\frac{1}{2}$  times higher, and in eleutherococcus treatment the survival was almost 5 times higher as compared with the control group. In the combined action of x-ray irradiation and overloading (rotation of mice for 15 sec-

onds in a centrifuge at 400 to 500 rounds per minute), the therapeutic effect of ginseng and eleutherococcus was more pronounced than in an isolated affection of experimental animals with x rays. (auth)

#### 12509

THE PERIPHERAL NERVOUS SYSTEM OF DOGS IN POLONIUM AFFECTION. B. I. Lebedev. *Med. Radiol.* 5, No. 2, 36-41(1960) Feb. (In Russian)

The state of the peripheral nervous system in dogs was studied at various periods following intravenous introduction of 0.005  $\mu\text{C/gm}$  of  $\text{Po}^{210}$  (chronic radiation sickness with death of the animals on the 6 to 7th month). The investigations disclosed that in all the nerve formations studied, there developed gradually progressing changes, manifested destructively at the peak of the disease, in the sympathetic extramural ganglia. They testify to lesions of the afferent, as well as efferent paths of the reflex arch. The noted peculiarities of changes of the peripheral nervous system apparently found their reflection in the general manifestations of the disease, having the nature of dystrophic lesions. (auth)

#### 12510

THE SPECIFIC FEATURES OF HEMATOPOIESIS IN RATS AND THEIR OFFSPRING IN THE ACTION OF  $\text{Sr}^{90}$ . T. A. Ivanova. *Med. Radiol.* 5, No. 2, 41-5(1960) Feb. (In Russian)

The introduction of  $\text{Sr}^{90}$  (0.4 mC/gm) to female rats before pregnancy was found to provoke a number of changes in the peripheral blood and hematopoietic organs not only in the rats but also in their offspring. On the 1st to 3rd day following  $\text{Sr}^{90}$  administration, an increase in the number of blood cells was observed in rats, due to mature cells from the bone marrow. The subsequent drop in the number of cells (3rd to 30th day) depended upon the disturbance of hematopoiesis, which was manifested by a retarded transition of reticular cells into blood cells and an inhibition of their maturation. Between the 2nd and 6th month a rise of the blood cell count was observed which was associated, apparently, with the restoration of the processes of differentiation and cell maturation in the hematopoietic organs. At later stages (7th to 11th month) a marked leukocytosis in the peripheral blood was observed, the latter being due to hyperplasia of the leukoblastic portion of the bone marrow. In the offspring of the irradiated female rats, pronounced fluctuations in the blood cell count of the peripheral blood were observed at the age of 1 to 3 months. The changes found in rats at a more advanced age (3 to 9 months) were characterized by marked leukocytosis of neutrophil nature and the appearance of plasmatic and reticular cells, associated with an increase of the leukoblastic portion in the bone marrow and a disturbance of processes of cell development and maturation. (auth)

#### 12511

THE REACTIVITY OF THE HEART TO CERTAIN PHARMACOLOGICAL AGENTS IN RABBITS AFFECTED WITH POLONIUM (ELECTROCARDIOGRAPHIC DATA). B. B. Moroz and S. P. Grozdou. *Med. Radiol.* 5, No. 2, 46-50 (1960) Feb. (In Russian)

Electrocardiographic data are presented on the reaction of the myocardium to adrenaline, carbocholine, ephedrin, and nitroglycerin in rabbits at different stages of acute radiation sickness induced by polonium. There were divulged changes in the excitability and conductivity of the myocardium in which two developmental stages could be distinguished. In the first stage the sensitivity of the heart was elevated. After the introduction of adrenaline, brady-

cardia intensified, extrasystoles were observed more often and ventricular flutter and heterotopic ventricular rhythm was observed. The administration of carbocholine produced a sharper retardation of atrioventricular conductivity, even an incomplete block of the II to III degree, etc. In the second stage, as compared with the early periods of radiation sickness, a drop of cardiac sensitivity was observed. The reactivity of the heart to adrenaline, carbocholine, and nitroglycerin, especially at late stages, was considerably reduced or the myocardial reaction was absent completely. At the peak of radiation sickness marked changes of the electrocardiogram were seen which were indicative of dystrophic processes in the myocardium (a drop of the wave P amplitude and QRS complex, a rise and a sharpening of T wave a lengthening of the QRST complex, and displacement of the isoelectric axis to the right). An elevated sensitivity of the heart during the first stage was apparently associated with disturbances of extracardiac innervation, especially with the increase of parasympathetic influences. A diminution of the cardiac reaction in the second stage was possibly due to a weakening of extracardiac reflexes and affection of the cardiac muscle as well. (auth)

#### 12512

THE INFLUENCE OF CALCIUM DISODIUM SALT OF DIAMINOCYCLOHEXANE-TETRA-ACETIC ACID ON PLUTONIUM EXCHANGE IN RATS. Yu. A. Belyaev. *Med. Radiol.* 5, 54-8(1960) Feb. (In Russian)

The influence of the calcium disodium salt of diaminocyclohexane tetraacetic acid on  $\text{Pu}^{239}$  exchange in rats was studied. Plutonium was introduced intraperitoneally in the form of a citrate complex. The action of the above substance was studied in intraperitoneal (10, 40, and 100 mg per rat) as well as in peroral introduction for 3 and 30 days after the administration of the substance. In some experiments the preparation was given in conjunction with zirconium citrate. It was demonstrated that the given complex is most effective in  $\text{Pu}^{239}$  excretion from the liver by decreasing its content nearly twice and in the skeleton, up to 80 to 83%, as compared with the control animals. It was ineffective in peroral administration. In combined intraperitoneal introduction of calcium disodium salt of diaminocyclohexane tetraacetic acid and zirconium citrate the plutonium content decreased in the skeleton, whereas in peroral administration the plutonium content was decreased in the liver. (auth)

#### 12513

INABILITY OF THIOTAURINE TO PROTECT MICE AGAINST IONIZING RADIATION. D. Cavallini and L. Tentori (Univ. of Modena, Italy and Istituto Superiore di Sanità, Rome). *Nature* 186, 254(1960) Apr. 16.

The validity of the presumed correlation between radiochemical degradation and biological protection was investigated by comparing the protective effects of thio-taurine and cysteamine against a lethal dose of x radiation in mice. All thio-taurine-treated mice died within 10 days of irradiation while about 50% of the cysteamine-injected mice lived. Possible reaction mechanisms are discussed. (C.H.)

#### 12514

THE TREATMENT OF ACUTE RADIATION SICKNESS WITH PACKED PLATELETS. A. A. Bagdasarov, M. O. Raushenbakh, G. M. Abdullaev, B. F. Beliaeva, and N. Ya. (Ia.) Lagutina (Central Order of Lenin Inst. of Hematology and Blood Transfusion, Ministry of Health, USSR). *Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation)* 4, No. 8, 1-7(1959).



Transfusions of freshly prepared, sound packed blood platelets were found to be an effective therapeutic measure in combating hemorrhage in radiation sickness. Possible mechanisms involved are discussed. (C.H.)

#### 12515

RELATIONSHIP BETWEEN THE CELL COMPOSITION OF THE STERNAL MARROW AND THE PERIPHERAL BLOOD IN DOGS IN THE ACUTE PHASE OF RADIATION SICKNESS CAUSED BY STRONTIUM 90. Communication I. I. K. Petrovich. Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation) 4, No. 8, 34-7(1959).

Counting the absolute number of nucleated cells in sternal puncture material was found to be an effective way of determining the character, sequence, and trend of hematopoietic processes in acute radiation sickness. It is necessary to make a quantitative comparison of the composition of the bone marrow and the peripheral blood. Data are tabulated from a study in dogs during the acute phase of radiation sickness caused by strontium-90. (C.H.)

#### 12516

THE STATE OF THE INTRINSIC FACTOR OF CASTLE-VITAMIN B<sub>12</sub> SYSTEM IN CHRONIC RADIATION SICKNESS. S. S. Vasiliskii. Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation) 4, No. 8, 38-45(1959).

Results are reported from a study of the state of the intrinsic factor of Castle-vitamin B<sub>12</sub> system in dogs and rats exposed to chronic irradiation. The influence of this system on reticulocyte reactions is discussed. The results of the experiments showed that the level of vitamin B<sub>12</sub> in the blood and its content in the liver are not lowered in chronic radiation sickness. (C.H.)

#### 12517

USE OF POLYGLUCIN IN HEMORRHAGE WITH BACKGROUND OF RADIATION AFFECTION. A. A. Lipats and N. V. Nikolayeva (Central Order of Lenin Inst. of Hematology and Blood Transfusion, Ministry of Health, USSR). Problems Hematol. Blood Transfusion (U.S.S.R.) (English Translation) 4, No. 8, 65-9(1960).

Transfusions of polyglucin, a blood plasma substitute, resulted in the rapid recovery of dogs from the symptoms of hemorrhagic shock induced by acute radiation sickness. (C.H.)

#### 12518

THE EFFECT OF PARAMAGNETIC GASES ON THE ELECTRON SPIN RESONANCE SIGNAL FROM ACTIVATED CHARCOAL. J. W. Hunt, L. H. Gray, and J. W. Boag (Ontario Cancer Inst., Toronto and Mount Vernon Hospital, Northwood, Middx, Eng.). Radiation Research 12, 319-24(1960) Apr.

The quenching action on electron spin resonance signal from activated charcoal was investigated under various conditions. The effects of oxygen, nitric oxide, and inert gases were studied. An attempt is made to explain the radiobiological effects of paramagnetic gases. Over the range of pressures covered in the investigations, none of the gases studied were able to displace oxygen from the sites it occupies when quenching the electron spin resonance signal from carbon. (C.H.)

#### 12519

RADIATION INJURY: ADRENOCORTICAL AND GASTRIC RESPONSES IN THE RAT. D. G. Baker, C. G. Hunter, and E. Schönbaum (Univ. of Toronto). Radiation Research 12, 409-16(1960) Apr.

From 1 hour to 4 days after exposure to whole-body

x irradiation (500 r), no changes were observed in adrenocortical activity of rats fed *ad libitum*. This was demonstrated in comparative studies of steroid formation *in vitro* and of ascorbic acid concentration of adrenal tissue. In rats fasted overnight and sacrificed 15, 30, or 45 minutes after irradiation, some stimulation of the adrenal cortex was observed. This occurred whether the rats were irradiated or sham-treated. Irradiation increased the weight of the stomach contents of rats within 45 minutes of exposure. (auth)

## CHEMISTRY

### General and Miscellaneous

#### 12520 AERE-C/M-335

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE PROBLEM OF CATALYTIC RECOMBINATION OF RADIOLYTIC GAS IN THE SLURRY BLANKET OF THE H.A.R.: EXPERIMENTS ON THE EFFICACY OF THE THORIA SURFACE. K. E. Francis and R. G. Sowden. Nov. 1957. 21p. (HARD(F)/P-7).

In-pile experiments have been carried out to investigate the efficacy of thoria in suspension as a catalyst for the recombination of radiolytic gas. The thoria surface appears to have some activity, but, although the mechanism is obscure, it can be stated with certainty that this activity is about two orders of magnitude too low to provide adequate internal recombination in an H.A.R. blanket. An added catalyst will therefore be required. (auth)

#### 12521 BM-RI-5596

Bureau of Mines

REDUCING TITANIUM TETRACHLORIDE WITH HIGH-SURFACE SODIUM. D. C. Fleck, M. M. Wong, and D. H. Baker, Jr. 1960. 13p.

A method of using sodium for reducing titanium tetrachloride, developed to improve the extractive metallurgy of titanium, is described. Finely divided titanium metal, titanium lower chlorides, or a mixture thereof was produced in a continuous operation at temperatures between 105 and 205°C by the reaction of molten sodium and vaporized titanium tetrachloride in an agitated bed of finely divided inert solids (powdered sodium chloride or the reaction products). Composition of the product was controlled by varying the relative quantities of sodium and titanium tetrachloride used. A description of the operations and analytical data of the reaction products are given. (auth)

#### 12522 CF-59-11-87

Oak Ridge National Lab., Tenn.

RETENTION OF BORON WITH MANNITOL DURING THE EVAPORATION OF ACID AND ACID-FLUORIDE SOLUTIONS. C. Feldman and P. V. Hoffman. Nov. 17, 1959. 4p. OTS.

Experiments are described in which boron was retained by mannitol in HCl and HCl-HF solutions while they were evaporated on steam baths. In experiments where no mannitol was used, boron losses of 30 to 50% were recorded. (J.R.D.)

#### 12523 CF-60-3-88

Oak Ridge National Lab., Tenn.

APPARENT COPPER RATE CONSTANTS DETERMINED IN IN-PILE LOOP EXPERIMENT L-2-22. G. H. Jenks and J. E. Baker. Mar. 23, 1960. 13p. OTS.

The results of radiolytic gas pressure measurements in the pressurizer of an in-pile loop experiment were used to calculate the copper rate constants in several different test solutions. The radiolytic gas pressures employed were those observed during normal operation of the experiment (i.e., main-stream and pressurizer solution temperatures of 280 and 295°C, respectively, and a solution circulating pump frequency of 60 cps). Values for the copper concentration, obtained from solution analyses, were combined with the solution rate constants to determine the apparent molar rate constant for each solution at 280°C. The values for the apparent molar rate constants thus determined were found to be about  $6,400 \text{ hr}^{-1} \times \text{M}^{-1} \times 1$  in a solution that was  $0.038 \text{ M } \text{UO}_2\text{SO}_4$ ,  $0.015 \text{ M } \text{H}_2\text{SO}_4$ , and  $0.0051 \text{ M } \text{CuSO}_4$  in  $\text{D}_2\text{O}$ , and to range from  $20,400$  to  $24,200 \text{ hr}^{-1} \times \text{M}^{-1} \times 1$  in two solutions that were  $0.038 \text{ M } \text{UO}_2\text{SO}_4$ ,  $0.09$  to  $0.095 \text{ M } \text{H}_2\text{SO}_4$ ,  $0.00091$  to  $0.0025 \text{ M } \text{CuSO}_4$ , and  $0.18 \text{ M } \text{Li}_2\text{SO}_4$  in  $\text{D}_2\text{O}$ . The difference in the apparent rate constants was not necessarily due to an increased copper activity in the additive-containing solutions. It may be indicative of an enhanced deuterium solubility or a decreased G-value in these solutions. Neither of these values was known for these additive solutions, and values estimated from those applying to additive-free uranyl sulfate solutions were employed. (auth)

#### 12524 CF-60-3-139

Oak Ridge National Lab., Tenn.

COMMENT ON CALCULATIONS BY LIETZKE AND STOUGHTON ON CONCENTRATIONS OF SPECIES IN AQUEOUS  $\text{UO}_2\text{SO}_4$  SOLUTIONS AS A FUNCTION OF TEMPERATURE. R. S. Greeley. Mar. 31, 1960. 31p. OTS.

Qualitatively, as illustrated with graphs, the calculated concentrations of the species in aqueous  $\text{UO}_2\text{SO}_4$  solutions appear to be essentially correct and move in the expected directions with changes in concentration of added acid and added sulfate salts. Undissociated uranyl sulfate is the dominant species at the higher temperatures (150 to 200°C) and the disulfate complex also plays a major role. Generally the uranyl and  $\text{U}_2\text{O}_7^{2+}$  ion concentrations are essentially negligible. (auth)

#### 12525 DASA-1168

Institute of Paper Chemistry, Appleton, Wis.

A STUDY OF THE FILTRATION AND PERMEABILITY CHARACTERISTICS OF IPC 1478 FILTER PAPER. Final Report. Feb. 13, 1960. 176p. Project 1983. Contract DA-29-044-XZ-549.

The filtration and pressure drop-flow rate characteristics of IPC 1478 filter paper was determined over wide ranges in pressure ( $1/20$  to  $1/6$  atm.) and temperature ( $-40$ ,  $0$ , and  $70^\circ\text{F}$ ). The retention of  $\text{SiO}_2$  spherical particles by the filter paper at a flow rate of  $5000 \text{ ft}^3/\text{min}$  at  $1/20$  atm. pressure and  $70^\circ\text{F}$  was found to be essentially 100%. The retention (generally 30 to 75%) for aluminum oxide particles (about  $40 \text{ \AA}$ ) and pressure drop were determined over wide ranges in pressure, temperature, and flow rate. The application of kinetic theory to small particle diffusion in a gas is discussed. The theory of diffusion of particles from a streaming gas to the tube wall was evolved and applied to the estimation of particle size. (C.J.G.)

#### 12526 GA-1109

General Atomic Div., General Dynamics Corp., San Diego, Calif.

EQUILIBRIUM CONCENTRATIONS OF SEVERAL GASEOUS SPECIES ( $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{H}_2$ ,  $\text{H}_2\text{O}$ ) IN EQUILIBRIUM WITH GRAPHITE AT VERY LOW HYDROGEN AND OXYGEN LEVELS. D. V. Ragone. Mar. 4, 1960. 17p. Contract AT(04-3)-187. OTS.

Equilibrium values of total gaseous carbon (sum of mole

fractions of  $\text{CO}$ ,  $\text{CO}_2$ , and  $\text{CH}_4$ ) are calculated as a function of total oxygen and total hydrogen in an inert gas at 500 to  $1500^\circ\text{F}$ . These calculations show that hydrogen can counteract the tendency of oxygen to transport carbon from regions of high temperatures to regions of low temperatures. (auth)

#### 12527 HW-40123

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

PURIFICATION OF MERCURY METAL. Karl Koyama. Nov. 22, 1955. 4p. Contract AT(45-1)-1350. OTS.

A purification method for mercury which employs a rotary scrubber and wash solutions of acid, water, and methyl alcohol is described. The mercury is subsequently filtered on a gold-adhesion filter. Various methods of determining the purity of mercury are discussed. (C.J.G.)

#### 12528 HW-64289

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

THE PREPARATION OF PLUTONIUM POWDER BY A HYDRIDING PROCESS—INITIAL STUDIES. G. L. Stiffler and M. H. Curtis. Mar. 10, 1960. 17p. Contract AT(45-1)-1350. OTS.

Micron-sized plutonium powder was produced by hydriding massive metal, then grinding and decomposing the hydride. An apparatus containing clean plutonium metal was evacuated to a pressure of  $10\mu$ . Dry oxygen-free hydrogen was introduced and the apparatus placed in a furnace. After the reaction started, the apparatus was removed from the furnace and hydrogen added until the reaction was complete. The hydride was decomposed by heating to  $400^\circ\text{C}$ . Plutonium metal produced in this manner was porous. (C.J.G.)

#### 12529 LS-61

Israel. Atomic Energy Commission, Tel-Aviv.

LITERATURE SURVEY ON ACTIVITY AND pH OF CARBONATE AND BICARBONATE SOLUTIONS. July 1959. 5p.

A bibliography is presented on the activity and pH of aqueous solutions containing carbonates and bicarbonates. The references were collected from Chemical Abstracts 1921–1959 (Nos. 1–10), Journal of Chemical Physics 1959 (No. 5), Journal de Chimie Physique 1959 (Nos. 1–4), and Zeitschrift für Physikalische Chemie 1959 (Nos. 1–6). 33 references. (T.R.H.)

#### 12530 NAA-SR-4545

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

SPACE GROUPS AND ATOMIC PARAMETERS IN SOME GRAPHITE-ALKALI METAL LAMELLAR COMPOUNDS. G. M. Wolten. Apr. 1, 1960. 18p. Contract AT-11-1-GEN-8. OTS.

The crystallographic aspects of alkali metal-graphite lamellar compounds are reviewed, and space groups and atomic parameters are derived for some of them.  $\text{NaC}_{64}$ ,  $\text{KC}_8$ , and  $\text{RbC}_8$  crystallize in space group C222. If  $\text{NaC}_{64}$  is one of a series of sodium-graphite compounds, other members of the series would be expected to crystallize in the same space group. The remaining eight known potassium and rubidium compounds have a slightly different but similar structure. Experimental data for these are insufficient to permit a unique choice of space group. (auth)

#### 12531 NAA-SR-Memo-4753

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

THE MAXIMUM SOLUBILITY OF WATER IN TERPHENYL



AND POLYPHENYLS. H. Mandel. Dec. 14, 1959. 10p. OTS.

An investigation was conducted to determine the solubility of water in terphenyl and polyphenyls. Results are presented graphically. (J.R.D.)

**12532** TID-5711

Michigan. Univ., Ann Arbor.

KINETICS AND MECHANISM FOR THE ELECTROCHEMICAL REDUCTION OF BENZOPHENONE IN ACIDIC MEDIA.

Report No. 53. Makoto Suzuki and Philip J. Elving.

Feb. 22, 1960. 40p. Contract AT(11-1)-70, Project 8. OTS.

The kinetic and mechanism factors in the electrochemical reduction of ketones were investigated by observation of the relations for the reduction of benzophenone and p-bromobenzophenone over the pH range of 2 to 7 such as variation of half-wave potential,  $E_{1/2}$ , with pH, ethanol concentration and drop-time; variation of current with time at potentials selected at various regions of the polarographic waves; and variation of the heterogeneous rate constant with pH, ethanol concentration and temperature. The pinacol produced by dimerization of the free radical formed in the first one-electron wave may form an insoluble film at the interface which has marked effects on the observed behavior. The electron-transfer process for the first wave is very rapid, but the subsequent irreversible chemical process (dimerization) causes the net reaction to appear irreversible. The process producing the second one-electron wave (reduction of free radical to carbinol) is quasireversible. The rate of the combined wave, observed above ca. pH 5, is controlled at first by the wave II process; with increasing pH, control shifts to the wave I process. The cause of the heretofore unobserved slight pH-dependency of wave II is discussed. (auth)

**12533** TID-5751

Pennsylvania. Univ., Philadelphia.

ANNUAL PROGRESS REPORT AND RENEWAL PROPOSAL ON INVESTIGATION OF THE CONSTRUCTION OF FUSED ELECTROLYTES. J. O'M. Bockris. Mar. 1960. 29p.

Contract AT(30-1)-1769. OTS.

A radiochemical modification of the capillary-reservoir technique for the measurement of diffusion coefficients was developed. The method was tested by measurement of the self-diffusion coefficient of sodium and the results were in agreement with values previously determined. A spectrophotometric study of inorganic halides was made. Techniques of operating a spectrophotometer were studied. Cathode potential transition times of various molten salt systems at constant applied current were investigated. Dendrites were grown at constant total current electrodeposition. At a fixed potential the growth rate of a dendrite was found to be a constant. The rates of growth of different dendrites from the same electrode were not always the same. The log of the growth rate was found to be proportional to the applied potential. Increasing the concentration of solute increased the growth rate and the slope of the log rate-potential curve. Critical current densities below which dendrites do not form were found to exist and to be reproducible to about  $\pm 10\%$ . The equations of state for molten salts are discussed. (C.J.G.)

**12534** TID-5761

Fordham Univ., New York.

TRENDS IN THE STABILITIES OF SOME RARE EARTH CHELATES (thesis). Albert S. Tompa. 1960. 81p. Contract AT(30-1)-906. OTS.

A potentiometric study of the cerium group rare earth chlorides with organic compounds such as the amino, hy-

droxy, and mercapto analogs of acetic, propionic, benzoic, and succinic acids is described. The study was undertaken to establish the stabilities of these chelates and their analogs and to determine stability trends. The experimental procedure involved a potentiometric titration of the organic acids in the absence and presence of the rare earth chlorides. Resulting data and conclusions are included. (J.R.D.)

**12535** AEC-tr-4035

THE STUDY OF PHASE TRANSFORMATION OF URANIUM OXIDES IN AIR. P. P. Budnikov, S. G. Tresvyatskii (Tresvetskii), and V. I. Kushakovskii. Translated for Argonne National Lab. from *Doklady Akad. Nauk S.S.S.R.* 128, 85-8(1959). 3p. JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, as abstract No. 119.

**12536** AEC-tr-4038

CHROMATOGRAPHY OF DINITROPHENOLS. Wataru Funasaka and Tsuguo Kojima. Translated for Los Alamos Scientific Lab. from *Bunseki Kagaku* 9, 33-7(1960). 11p. JCL.

Attempts were made to separate paranitrophenol, 2,4- and 2,6-dinitrophenols, and 2,4,6-trinitrophenol by paper chromatography and filter paper electrophoresis. By paper chromatography, good separations were obtained when filter paper, buffered with a buffer solution of citric acid, was used and the dinitrophenol mixture was developed with amyl alcohol-benzene which contained the same buffer solution. Good separations were obtained when filter paper, which had been treated with sodium acetate water solution, was used and the mixture was developed with amyl alcohol-benzene-acetic acid. By the filter paper electrophoresis method, separations were ascertained to be complete when a buffer solution of acetic acid-sodium acetate at pH 3.2 ~ 3.6 was used and electrophoresis was conducted for 1.5 hours at 500 v. With the objective of determining 2,6-dinitrophenol and 2,4,6-trinitrophenol in 2,4-dinitrophenol, the column electrophoresis method was investigated. It was found possible to determine 2,6-dinitrophenol and 2,4,6-trinitrophenol to the extent of 0.25%. (auth)

**12537** AEC-tr-4044

CONCERNING A MOLECULAR MECHANISM OF MUTAGENESIS BY NITROUS ACID. R. Lavalle. Translated by Gretchen Riese (Los Alamos Scientific Lab.) from *Compt. rend.* 250, 1134-6(1960). 5p. JCL.

The mode of mutagenic action of nitrous acid on normal desoxyribonucleic acid (DNA) with double helix is discussed. It is assumed that some of the genetic information is contained in the sequence of bases in DNA and that mutation is the result of substitution of a single pair of nucleotides by the other. The action of nitrous acid can be broken down into the formation of a nitrosamine and migration of the amino hydrogen onto the oxygen atom with the simultaneous appearance of the OH group and elimination of  $N_2$ . Then the hydrogen undergoes another shift, transforming the deaminated bases from the enol to the stable keto form. This happens at the moment of replication, and at the time of resynthesis of the double helix one pair of nucleotides will be replaced by the other pair. However, it is shown that the deamination of guanine ought not to give a mutational event. Thus, substitution of nucleotides would be the result of the action of nitrous acid on DNA when one of the four bases is adenine or cytosine. (D.L.C.)

**12538** JPRS-2394

METHODS AND TECHNIQUE OF PHYSICO-CHEMICAL RESEARCH. Ya. M. Varshavskii (Varshavskiy) and M. G.

Lozhnina. Translated from *Zhur. Fiz. Khim.* **31**, 911-14 (1957). 10p. OTS.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 11, as abstract No. 10010.

**12539** NP-tr-426

THE FLUIDISATION OF POWDERED BEDS. S. Yagi and K. Takagi. Translated by A. K. Henn (U.K.A.E.A. Atomic Energy Research Establishment) from *Kagaku Kikai* **15**, 212-17(1951). 13p. JCL.

Experiments were done with powdered pyrrhotite to ascertain the various conditions of fluidization of the particles. When the velocity ratio  $u/u_m$  and length to diameter ratio  $L_C/D_T$  have been determined for various conditions of the bed, it should be possible to bring about any desired state of fluidization by an appropriate choice of the values of these quantities. The bed height at which slugging occurs is inversely proportional to the square root of the particle diameter:  $(L_C/D_T)_{\text{slug}} = 1.2 D_p^{-0.5}$ . The bed height is shown to be given by  $L_f/L_C = 11\frac{1}{2}$ . (auth)

**12540** NP-tr-427

MIXING OF THE SOLID PHASE IN BAFFLED AND UNBAFFLED FLUIDISED SOLID-GAS SYSTEMS. L. Massimilla and S. Bracale. Translated by S. Fitzgerald (U.K.A.E.A. Atomic Energy Research Establishment) from *Ricerca sci.* **27**, 1509-25(1957). 23p. JCL.

The mixing of the solid phase in baffled and unbaffled fluidized systems consisting of beds of approximately spherical glass beads 0.7 mm in diameter in a column 90 mm in diameter is examined at various fluidizing gas velocities. Mixing of the solid phase was determined by adding tracer particles of the same dimensions and density as those forming the original bed, but of a different color. The results allow a determination of the range of values of gas velocity in which mixing of the solid takes place by diffusion in baffled and unbaffled fluidized systems. The diffusivities of the solid phase, determined experimentally, are shown in relation to the fluidizing gas velocity and to the relative expansion of the system. In accordance with the theoretical relationship established by Trawinski, the diffusivity of the solid phase is a linear function of the product of the fluidizing gas velocity and the relative expansion of the bed to the point at which the fluidized system ceases to be in a homogeneous state. (auth)

**12541**

CONSTITUTION AND PHYSICO-CHEMICAL PROPERTIES OF DOUBLE URANYL PHOSPHATES AND RELATED MATERIALS. V. STUDY OF THE POWDER DIAGRAMS (X RAY) AND OPTICAL EXAMINATION. F. González García and R. Romero Díaz (Facultad de Ciencias, Seville). *Anales real soc. espan. fis. y quim.* (Madrid), Ser. B. **56**, 51-66(1960) Jan. (In Spanish).

A study by powder x-ray-diffraction and optical methods of several uranyl-alkaline phosphates and related substances was made. This study agrees with the conclusions obtained by other physicochemical methods on the constitution and properties of these compounds. Three different crystal structures are suggested: one tetragonal autunite structure for the uranyl calcium phosphates with the higher hydration; one other tetragonal metaautunite structure for the calcium uranyl-phosphates with lower hydration and a rhombic structure common to the substituted K-autunites and K-uranyl synthetic phosphates. Optical examination agrees with this. (auth)

**12542**

THE SULFIDES  $\text{Me}_2\text{S}_3$  AND  $\text{Me}_3\text{S}_4$  OF THE RARE EARTH ELEMENTS. M. Picon, L. Domange, J. Flahaut, M. Guit-

tard, and M. Patrie (Faculté de Pharmacie, Paris). *Bull. soc. chim. France* No. 2, 221-8(1960) Feb. (In French)

The preparation and the crystallographic, magnetic, thermal, and chemical properties of the sulfides  $\text{Me}_2\text{S}_3$  of La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Er, Yb, and Y are described. Four crystalline varieties are found:  $\alpha$  (Ce, Pr, Nd, Sm, and Gd),  $\beta$  (La, Ce, Pr, and Nd),  $\gamma$  (La, Ce, Pr, Nd, Sm, Gd, and Dy), and  $\delta$  (Dy, Er, and Y). The cubic  $\gamma$  sulfides have a range of homogeneity which extends up to the composition  $\text{Me}_3\text{S}_4$ . Metallic properties appear with the first four elements, whereas the saline character persists with samarium and europium because of the existence of bivalent ions. (tr-auth)

**12543**

COMPOUNDS FORMED BY SULFIDES OF THE RARE EARTH ELEMENTS. I. COMPOUNDS WITH ALUMINUM SULFIDE AND GALLIUM SULFIDE. Louis Domange, Jean Flahaut, and Madeleine Patrie (Faculté de Pharmacie, Paris). *Bull. soc. chim. France* No. 2, 229-31(1960) Feb. (In French)

The sulfides of La, Ce, Pr, Nd, Sm, Gd, Er, and Y combine with the sulfides of aluminum and gallium. The compounds formed  $\text{ABS}_3$  all belong to the same hexagonal crystalline system. Their principal properties are described. (tr-auth)

**12544**

COMPLEX FORMATION AND COMPLEX-ELUTION OF THE RARE EARTHS. L. Wolf. *Chem. Tech. (Berlin)* **10**, 590(1958). (Translated from *Referat. Zhur. Khim.* No. 9, 1959, abstract No. 30748).

Dibasic ethanolaniline diacetic acid and *o*-cyclohexanolamine diacetic acid ( $\text{H}_2\text{Z}$ ) have been used as complexing reagents for the rare earths (RE). Compared to other complexing reagents, the  $\text{H}_2\text{Z}$  acids and their complexes with the RE are more soluble and have more favorable temperature coefficients of solubility. As a result the complex elution of the RE is not accompanied by the formation of a deposit on the column. The  $\text{H}_2\text{Z}$  can be tri- or tetra-dentate ligands and can form both cation complexes of the type  $\text{MZ}^+$  and anion complexes of the type  $\text{MX}_2^-$ . The interconversion of the complexes is expressed by the equations:  $\text{MZH}_2 + \text{OH}^- \rightleftharpoons \text{MZ}_2^- + \text{H}_2\text{O}$  and  $\text{MZ}_2^- + \text{H}^+ \rightleftharpoons \text{MZ}^+ + \text{HZ}^-$ . The reaction may proceed via the intermediate formation of the hydroxy complex  $\text{MZOH}$  which is capable of polymerizing. In the elution of the RE with the  $\text{H}_2\text{Z}$  both the anion and cation complexes are present; as the zones move down the column the equilibrium is shifted toward the more stable cation complexes. The chemical processes in the resin are discussed with reference to the field structure, negative charge distribution, and distribution of  $\text{SO}_3\text{H}$  groups.

**12545**

THE EXISTENCE AND SOME PROPERTIES OF THE NEUTRAL SELENITE OF TETRAVALENT URANIUM,  $\text{U}(\text{SeO}_3)_2$ . Parviz Khodadad (Université, Paris). *Compt. rend.* **250**, 1273-5(1960) Feb. 15. (In French)

A method is described for the preparation of  $\text{U}(\text{SeO}_3)_2$ . The preparation is delicate because of the particular characteristics of the product. A study of the chemical properties has shown the existence of an intramolecular oxide reduction phenomenon. The selenite is a greenish blue powder which must be protected from air. It is difficult to dissolve in acids. Thermal decomposition in a vacuum produces  $(\text{UO}_2)(\text{SeO}_3)$ , Se, and  $\text{SeO}_2$ ; in a pressure maintained at 1/1000 mm Hg the decomposition products are  $\text{U}_3\text{O}_8$ , Se,  $\text{SeO}_2$ , and  $\text{O}_2$ . (tr-auth)



## 12546

THE CRYOMETRY AND THERMAL ANALYSIS OF MIXTURES OF FUSED SILVER AND POTASSIUM CHLORIDES AND BROMIDES. Yves Doucet and Michel Bizouard. *Compt. rend.* **250**, 1444-6(1960) Feb. 22. (In French)

The thermal analysis of mixtures of KBr + AgCl and KCl + AgBr in all concentration ranges shows a great similarity. There is a formation of mixed crystals and a singular point for the equimolecular KBr-AgCl or KCl-AgBr mixtures. The partition coefficients in the solid and liquid phases are given for some points. (tr-auth)

## 12547

PREPARATION OF THE POWDERY OXIDE  $UO_2$  BY THE ACTION OF WATER VAPOR ON CALCIO THERMAL URANIUM. Claude Moreau and Louis Barnoud (Centre d'Études Nucléaires, Grenoble, France). *Compt. rend.* **250**, 1495-7(1960) Feb. 22. (In French)

The oxidation method used permits the control and variation of the reaction velocity in preparing samples of uranium oxidized to a predetermined degree. The solid reactant, composed of spherical uranium grains of the same size, constitutes an interesting material for application of the principles of heterogeneous kinetics. (tr-auth)

## 12548

EFFECT OF THE POROSITY OF THE LENGTH OF THE ABSORPTION CURVE OF PURE YTTRIUM GARNET AND SUBSTITUTED WITH Cr AND Al. Roger Vautier and André-Jean Berteaud (Laboratoire de Magnétisme et de Physique du Solide, Bellevue, France). *Compt. rend.* **250**, 1812-14(1960) Mar. 7. (In French)

The length  $\Delta H_a$  of the resonance curve decreases with the porosity for the pure garnet and for garnets substituted by Cr or Al. With equal porosity Al decreases  $\Delta H_a$  and Cr increases  $\Delta H_a$ . (tr-auth)

## 12549

THE ELECTROCHEMICAL CORROSION OF FRITTED ALUMINA IN A BATH OF SODIUM METASILICATE. Maurice Doderio and Michel Darcy (E.N.S., Électrochimie et Électrometallurgie, Grenoble, France). *Compt. rend.* **250**, 1842-4(1960) Mar. 7. (In French)

The corrosion of fritted alumina in a bath of sodium metasilicate at 1200°C is sharply increased by a positive polarization but is not affected by a negative polarization. This dissymmetry is considered in making a hypothesis on the mode of conduction of the alumina. The conduction is electronic in the first case and ionic in the second. (tr-auth)

## 12550

DECONTAMINATION OF WATER CONTAINING  $Cs^{137}$ . E. Cerrai and C. Triulzi (Centro Informazioni Studi Esperienze, Milan). *Energia elettrica* **36**, 9p.(1959). (In Italian)

The method of decontamination of liquids (tap and distilled water) containing  $Cs^{137}$  in quantities from  $5 \times 10^{-8}$  to 50 mg/l, which corresponds approximately to an activity of 5  $\mu$ c/l to 5 c/l, was studied. Some Italian bentonites, natural and activated, were shown to be particularly effective as adsorbents of the radiocesium. The effects of pH, mixing time, and the amount of clay on the decontamination values were studied. In some cases, the behavior and the turbidity of the supernatant liquid and the filtration time of the sludge were described. (tr-auth)

## 12551

EXTRACTION OF ZIRCONIUM BY REDUCTION OF ZIRCONIUM TETRACHLORIDE AND BY ELECTROLYSIS. F. Plzak and V. Klabík. *Hutnické listy* **13**, 26-33(1958).

(Translated from *Referat. Zhur. Khim.* No. 9, 1959, abstract No. 31902).

The method of extraction of  $ZrCl_4$  by the chlorination of  $ZrO_2$  and the reduction of  $ZrCl_4$  to Zr by a Mg powder, and also the method of extraction of the Zr powder by the electrolysis of melted  $K_2ZrF_6$ , is introduced. Comparative investigations of these methods of Zr extraction from various kinds of raw materials were conducted.

## 12552

THE PLASMA JET IN HIGH TEMPERATURE RESEARCH. Sidney Katz, Edwin J. Latos, and Elliott Raisen (Illinois Inst. of Tech., Chicago). *Ind. Eng. Chem.* **52**, 289-92 (1960) Apr.

An examination of plasma jets is given with emphasis on high-temperature research. The basic characteristics of jet functions are discussed. Some applications of plasma jets in high-temperature research in various fields are suggested. The plasma jet is capable of producing temperatures of 50,000°C, power of  $3 \times 10^6$  watts, and velocities to Mach 20. Factors limiting attainable temperatures are electrical energy input, energy losses, and electrode cooling techniques. (B.O.G.)

## 12553

POLYMERIZATION OF URANYL-TIRON CHELATES. Richard L. Gustafson, Claudette Richard, and Arthur E. Martell (Clark Univ., Worcester, Mass.). *J. Am. Chem. Soc.* **82**, 1526-34(1960) Apr. 5.

The interaction of uranyl ion with Tiron (pyrocatechol-3,5-disodium sulfonate) was studied potentiometrically and spectrophotometrically in the pH range 2 to 11. Below pH 3.5 the solutions contain primarily 1:1 mononuclear chelate species although polymeric forms of the unhydrolyzed chelates may exist to some extent. Further reaction of the monomeric chelate with hydroxide ion results in polymerization to a ternuclear species which is completely formed at pH 5.3. These reactions are independent of the amount of excess Tiron employed. Equilibrium constants were calculated which describe the initial buffer region within approximately 0.03 pH unit over a wide range of metal chelate concentration. Further interaction of Tiron with the ternuclear complex in the pH range 5.3-8.5 produces a chelate compound containing  $2\frac{1}{3}$  moles of Tiron per gram-ion of uranyl salt. The hydrolytic behavior of the  $UO_2^{++}$  ion was investigated in the pH range 2.5-5.5. Evidence for the existence of a mononuclear hydrolyzed species,  $UO_2(OH)^{+1}$ , was found and equilibrium constants have been calculated for the various hydrolytic and polymeric reactions involved. General equations for deducing the formulas of polynuclear metal chelate species have been derived. (auth)

## 12554

POLAROGRAPHIC DETERMINATION OF FORMATION CONSTANTS OF COMPLEX IONS IN FUSED  $LiNO_3-KNO_3$ . Joe H. Christie and Robert A. Osteryoung (Rensselaer Polytechnic Inst., Troy, N. Y.). *J. Am. Chem. Soc.* **82**, 1841-4(1960) Apr. 20.

A polarographic study of the chloro-complexes of Pb(II), Cd(II), and Ni(II) was made with the dropping mercury electrode in a fused  $LiNO_3-KNO_3$  mixture at 180°C. Respectively, 3, 4, and 2 chloro-complexes were found for these ions yielding these formation constants: Pb(II),  $K_1 = 42$ ,  $K_2 = 3$ ; Cd(II),  $K_1 = 200$ ,  $K_2 = 15$ ,  $K_3 = 40$ ,  $K_4 = 5$ ; Ni(II),  $K_1 = 26$ ,  $K_2 = 2$ ,  $K_3 = 10$ . The results are compared with other available data. (auth)

## 12555

INTRAMOLECULAR CARBON ISOTOPE EFFECT IN THE DECARBOXYLATION OF MALONIC ACID IN DIOXANE

SOLUTION. Peter E. Yankwich and Richard M. Ikeda (Univ. of Illinois, Urbana). *J. Am. Chem. Soc.* **82**, 1891-4(1960) Apr. 20.

The intramolecular carbon isotope effect in the decarboxylation of malonic acid in dioxane solution was studied between 89 and 139°C. Through comparison of the results with those obtained earlier for the intermolecular isotope effect in the same solvent and those obtained from studies of both isotope effects in quinoline solutions, values were obtained for the various complexing equilibrium contributions to the over-all isotope fractionation which agree well with values reported previously and with predictions of absolute and relative magnitude made by Bigeleisen and Wolfsberg. The very high temperature dependence of the isotope effect is indicative of a temperature-independent factor in the isotopic rate constant ratio not much greater than unity, and which appears to be somewhat less than unity on the basis of calculations with two very different models. There seems to be no obvious explanation for this deviation from theoretical expectation. (auth)

#### 12556

HYDROGEN ATOM ABSTRACTION REACTIONS BY CYANIDE ION-RADICALS. T. W. Martin and C. E. Melton (Oak Ridge National Lab., Tenn.). *J. Chem. Phys.* **32**, 700-4(1960) Mar.

Ion-molecule reactions of low energy (0 to 0.15 eV)  $\text{CHN}^+$  and  $\text{CH}_3\text{N}^+$  were shown conclusively to follow a hydrogen atom abstraction mechanism of the type,  $\text{XH}^+ + \text{YH} \rightarrow \text{XH}_2^+ + \text{Y}$ . These reactions were presumably bimolecular being first order with respect to each reactant over the pressure range  $10^{-7}$  to  $10^{-3}$  mm Hg. The rates of these reactions were markedly influenced by the molecular structure of both the cyanide ion and the hydrogen donor (YH). Ion-molecule reactions of this type were similar to the hydrogen atom abstraction processes of free radicals, but differed in having no appreciable temperature coefficients (in the range of 100 to 215°C), and in having much larger rate constants. On the basis of this study, chemical species having unpaired electrons whether charged (ion-radicals) or uncharged (free radicals) were shown to undergo similar types of reactions. Possible implications of these observations to the field of radiation chemistry are discussed. (auth)

#### 12557

KINETIC STUDIES OF HYDROXYL RADICALS IN SHOCK WAVES. III. THE OH CONCENTRATION MAXIMUM IN THE HYDROGEN-OXYGEN REACTION. Garry L. Schott (Los Alamos Scientific Lab., N. Mex.). *J. Chem. Phys.* **32**, 710-16(1960) Mar.

The chemical reaction zone in shock waves in  $\text{H}_2\text{-O}_2\text{-Ar}$  mixtures was studied using an ultraviolet line absorption technique to measure the OH radical concentration. The observed reaction course consisted of an induction period followed by a sharp rise of [OH] to a maximum and then slow disappearance of OH. The [OH] maxima measured in rich, lean, and stoichiometric mixtures at  $1000^\circ \leq T \leq 2600^\circ\text{K}$  and over a sevenfold range of density revealed that the reaction occurs in two distinct steps. The intermediate condition, in which [OH], [H], and [O] reach values greatly in excess of their equilibrium ones, was approximately a state of equilibrium among the three independent bimolecular reactions which is reached before any significant recombination has occurred. The relationship of these results to experiments near the explosion limits and in flames was emphasized. The occurrence of this overshoot in atom and free radical concentrations, which was very pronounced in hydrogen-oxygen flames but is not observed

in many hydrocarbon flames, is related to the decrease in number of moles which occurs in the oxidation of hydrogen but not of most other fuels. (auth)

#### 12558

INTERACTION OF HYDROGEN WITH TUNGSTEN. T. W. Hickmott (General Electric Research Lab., Schenectady, N. Y.). *J. Chem. Phys.* **32**, 810-23(1960) Mar.

Measurements were made, under ultra-high vacuum conditions, of the rates and isotherms for the adsorption of hydrogen on tungsten, the rate of desorption of hydrogen from tungsten, and the rate of formation of atomic hydrogen by an incandescent tungsten filament. When hydrogen chemisorbs on tungsten at 77°, the sticking probability is 0.1 and two distinct states of binding,  $\alpha$  and  $\beta$ , may be isolated at adsorption pressures as low as  $2.5 \times 10^{-9}$  mm. Analysis of desorption kinetics of the most tightly-bound state,  $\beta$ , revealed that hydrogen chemisorbs as atoms since evaporation is second order in adsorbed hydrogen. For  $n_\beta \leq 30 \times 10^{12}$  molecules/cm<sup>2</sup>,  $v_M = (5 \times 10^{-3})n_\beta^2 \exp(-31,000/RT)$  molecules/cm<sup>2</sup>-sec. At higher coverages, a decrease in heat of desorption was observed, which is due to surface heterogeneity. At equilibrium, the amount adsorbed in the  $\beta$  state obeyed a Temkin isotherm between 273 and 373°K; evaporation of hydrogen in the  $\beta$  state occurred down to temperatures as low as 77°K. Isothermic heats agreed with heats derived from desorption measurements. The  $\alpha$  state, populated before the  $\beta$  state is saturated at 77°K, was found proportional to hydrogen pressure and probably consists of molecular hydrogen on top of the primary atomically chemisorbed layer. The rate of evaporation of atomic hydrogen when the filament temperature was raised above 1100°K was  $v_A = (2.2 \times 10^{13})n \exp(-67,000/RT)$  molecules/cm<sup>2</sup>-sec. For pressures below  $10^{-7}$  mm and filament temperatures above 1475°K, the fraction of molecules striking the filament surface that is dissociated was constant and at least 0.05. Values of surface coverage and the rate of formation of atomic hydrogen as a function of filament temperature and hydrogen pressure were derived from experimental data. (auth)

#### 12559

ELECTRON DIFFRACTION STUDY OF MONOMETHYL- AND DIMETHYLPHOSPHINE. L. S. Bartell (Iowa State Univ., Ames and Univ. of Michigan, Ann Arbor). *J. Chem. Phys.* **32**, 832-4(1960) Mar.

The structural parameters of gaseous monomethyl- and dimethylphosphine were determined by the sector-microphotometer method of electron diffraction. The center of gravity bond distances and standard errors for the two molecules were, respectively:  $r_{\text{CP}} = 1.858 \pm 0.003$  and  $1.853 \pm 0.003$  Å;  $r_{\text{CH}} = 1.094 \pm 0.008$  and  $1.097 \pm 0.007$  Å; and  $r_{\text{PH}} = 1.423 \pm 0.007$  and  $1.445 \pm 0.02$  Å. The angles  $\text{P-C-H}$  were  $109.6 \pm 1$  and  $109.8 \pm 0.7^\circ$ . In dimethylphosphine the angle  $\text{C-P-C}$  was  $99.2 \pm 0.6^\circ$ . The methyl groups were found to be in staggered conformations. The distances and root-mean-square amplitudes of vibration agreed well with the values determined in recent studies of phosphine and trimethylphosphine. (auth)

#### 12560

VARIATION OF A CHEMICAL REACTION CROSS SECTION WITH ENERGY. E. F. Greene, R. W. Roberts, and J. Ross (Brown Univ., Providence). *J. Chem. Phys.* **32**, 940-1(1960) Mar.

The variation of a chemical reaction cross section with energy was studied for the reaction  $\text{K} + \text{KBr} \rightarrow \text{KBr} + \text{H}$  using molecular beam techniques. The minimum molecu-



lar activation energy for any one of the reaction cross sections at a scattering angle of  $35^\circ$  was found to be 1.4 kcal./mole. (C.J.G.)

#### 12561

TRANSIENT SPECIES IN THE FLASH PHOTOLYSIS OF HALOGENS IN SOLUTION. N. K. Bridge (Argonne National Lab., Lemont, Ill.). *J. Chem. Phys.* **32**, 945-6 (1960) Mar.

The transient species detected in the flash photolysis of  $\text{Br}_2$  and  $\text{I}_2$  in  $\text{NH}_4\text{SO}_4$ ,  $\text{CCl}_4$ , and hexane solutions were studied. All the transients were found to increase absorption below 350 m $\mu$ . (C.J.G.)

#### 12562

ON THE RADIATION-INDUCED GAS-PHASE POLYMERIZATIONS OF ACETYLENE AND BENZENE. A. Russell Jones (Oak Ridge National Lab., Tenn.). *J. Chem. Phys.* **32**, 953-4 (1960) Mar.

The infrared absorption spectrum of the radiation-induced gas-phase polymerizations of acetylene and benzene were examined. The spectrum of cuprene indicated aromatic cyclization while the pattern of the benzene polymer resembled that of irradiated polystyrene. (C.J.G.)

#### 12563

FLOCCULATION, SUBSIDENCE AND FILTRATION OF PHOSPHATE SLIMES. VI. A QUANTITATIVE THEORY OF FILTRATION OF FLOCCULATED SUSPENSIONS. Robert H. Smellie, Jr. and Victor K. La Mer (Trinity Coll., Hartford, and Columbia Univ., New York). *J. Colloid Sci.* **13**, 589-99 (1958) Dec.

A quantitative theory of filtration of suspensions flocculated with polymeric flocculants is developed. The theory, based upon a simple picture of the adsorption of the flocculant combined with considerations of floc geometry and the Kozeny-Carman permeability equation, explains the variations of filtration rate with flocculant concentration observed experimentally. (auth)

#### 12564

THE HIGH TEMPERATURE THERMODYNAMIC FUNCTIONS OF CERIUM, NEODYMIUM AND SAMARIUM. F. H. Spedding, J. J. McKeown, and A. H. Daane (Ames Lab., Ames, Iowa). *J. Phys. Chem.* **64**, 289-94 (1960) Mar.

The high-temperature enthalpies of cerium, neodymium, and samarium were measured from 0 to 1100°C. The heat capacity and related thermodynamic quantities are tabulated at 50-degree intervals. The heats of transition and fusion were determined for these metals, with cerium having the lowest values and samarium the highest. Correlation was made between the results and calculated quantities contributing to the heat capacity of metals. (auth)

#### 12565

THE DENSITY AND ELECTRIC CONDUCTANCE OF THE MOLTEN SYSTEM CERIUM-CERIUM CHLORIDE. G. W. Mellors and S. Senderoff (National Carbon Co., Cleveland). *J. Phys. Chem.* **64**, 294-300 (1960) Mar.

The density and electric conductance of the Ce-CeCl<sub>3</sub> system were measured from the pure salt to the almost saturated solution (8 mole % Ce) at 850, 900, and 950°C. The density of pure CeCl<sub>3</sub> is 3.216 g/cc at 850°. It decreases by about 1.5% on addition of 0.3 mole % Ce metal after which an almost linear increase to 3.287 g/cc at 8 mole % Ce is observed. The specific and equivalent conductances of pure CeCl<sub>3</sub> are 0.9600 ohm<sup>-1</sup> cm<sup>-1</sup> and 24.54 ohm<sup>-1</sup> cm<sup>2</sup>, respectively, at 850°. Large increases in these values (43 and 46%, respectively) are observed on the initial

addition of Ce metal corresponding to a concentration of 0.63 mole %. Beyond this initial addition the conductivity rises slowly to values of 1.8900 ohm<sup>-1</sup> cm<sup>-1</sup> and 48.26 ohm<sup>-1</sup> cm<sup>2</sup> at 7.75 mole % Ce. The large effects of low concentration of Ce on the density and conductivity of the system are explained by postulating the existence of comparatively free electrons resulting from the reaction  $\text{Ce}^0 \rightarrow \text{Ce}^{1+} + e^-$ , some of which are trapped by the reaction  $\text{Ce}^{3+} + 2e^- \rightleftharpoons \text{Ce}^{1+}$ . The comparatively free electrons in the systems dilute in Ce metal have large "molar volumes" and high mobilities as observed in Na-liquid ammonia systems. The electronic "molar volume" and mobility are reduced rapidly with increasing amounts of added cerium so that the conductivity mechanism at higher concentration becomes uncertain, although it is likely that even at the highest concentration there is still some component of electronic conductivity. (auth)

#### 12566

ABSORPTION SPECTRA IN FUSED SALTS. Norman W. Silcox and Helmut M. Haendler (Univ. of New Hampshire, Durham). *J. Phys. Chem.* **64**, 303-6 (1960) Mar.

The absorption spectra of eight anhydrous metal chlorides dissolved in a magnesium chloride-potassium chloride-sodium chloride eutectic were observed at 430°C in the spectral region from 230 to 400 m $\mu$ . The chlorides used were those of copper(II), nickel(II), cobalt(II), manganese(II), iron(III), uranium(III), uranium(IV), and uranyl. (auth)

#### 12567

SOLUBILITY OF PLUTONIUM TRIFLUORIDE IN FUSED-ALKALI FLUORIDE-BERYLLIUM FLUORIDE MIXTURES. C. J. Barton (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.* **64**, 306-9 (1960) Mar.

The solubility of PuF<sub>3</sub> in five LiF-BeF<sub>2</sub> mixtures, three NaF-BeF<sub>2</sub> mixtures, and two NaF-LiF-BeF<sub>2</sub> mixtures was determined at 550 to 650°C. The data follow a linear relationship when plotted as log of molar concentration of PuF<sub>3</sub> versus 1/T(°K.). The solubility of PuF<sub>3</sub> in these solvents is rather low, varying from about 0.4 to 2.5 mole % at 650°C, and from 0.16 to 1.0 mole % at 550°C. Minima in solubility-composition diagrams for the binary systems at 565° occur at 63 mole % LiF (0.3 mole % PuF<sub>3</sub>) and 57 mole % NaF (0.18 mole % PuF<sub>3</sub>). The effect of ThF<sub>4</sub>, BaF<sub>2</sub>, and CeF<sub>3</sub> in diminishing the solubility of PuF<sub>3</sub> in LiF-BeF<sub>2</sub> (63-37 mole %) was determined. The solubility of PuF<sub>3</sub> in the mixture LiF-BeF<sub>2</sub>-UF<sub>4</sub> (70-10-20 mole %) was found to be higher than in an LiF-BeF<sub>2</sub> solvent having the same concentration of LiF. (auth)

#### 12568

VAPOR PRESSURE OF THORIUM. A. J. Darnell, W. A. McCollum, and T. A. Milne (Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.). *J. Phys. Chem.* **64**, 341-6 (1960) Mar.

The vapor pressure of solid thorium was determined over the temperature interval 1484 to 1683°C by the vacuum evaporation method of Langmuir. Special purification of the thorium was necessary since traces of ThO<sub>2</sub> react with thorium to give ThO(g). Thorium also reacts with residual gaseous oxygen in the vacuum system to form ThO(g). The latter effect was found to be negligible at residual oxygen pressures of less than  $2 \times 10^{-6}$  mm. The vapor pressure equation for Th(s)  $\rightarrow$  Th(g) is  $\log P_{\text{atm}} = -28,780 \pm 620/T^\circ\text{K.} + 5.991 \pm 0.333$ . These results yield values of  $\Delta H_{298}^0(\text{Subl})$  of  $137.3 \pm 2.8$  kcal./mole and  $136.6 \pm 0.5$  kcal./mole from a slope and third law determination, respectively. From an estimate of the pressure of ThO(g) over Th(s) containing ThO<sub>2</sub>(s),  $D_{\text{ThO}}^0(\text{ThO}) = 196$  kcal./mole. (auth)

## 12569

SUBSTITUTION REACTIONS OF OXALATO COMPLEX IONS. II. KINETICS OF AQUATION OF TRISOXALATO-CHROMIUM(III) ION-SOLVENT DEUTERIUM ISOTOPE EFFECT. Kotra V. Krishnamurthy and Gordon M. Harris (Univ. of Buffalo). *J. Phys. Chem.* **64**, 346-9(1960) Mar.

The kinetics of aquation of the ion  $\text{Cr}(\text{C}_2\text{O}_4)_3^{3-}$  were studied as a function of complex ion concentration, acidity, added oxalic acid, temperature and heavy water solvent composition, using a spectrophotometric method. The total reaction in strongly acid solution is  $\text{Cr}(\text{C}_2\text{O}_4)_3^{3-} + 2\text{H}_3\text{O}^+ \rightarrow \text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2^- + \text{H}_2\text{C}_2\text{O}_4$ . The observed kinetic data is consistent with the rate law  $-\text{d}(\text{Cr}(\text{C}_2\text{O}_4)_3^{3-})/\text{dt} = k'(\text{H}_3\text{O}^+)(\text{Cr}(\text{C}_2\text{O}_4)_3^{3-}) + k''(\text{H}_3\text{O}^+)^2(\text{Cr}(\text{C}_2\text{O}_4)_3^{3-})$ . The mixed order with respect to  $(\text{H}^+)$  is interpreted in terms of a rapid pre-equilibration of complex with one proton, followed by either non-catalyzed or acid-catalyzed displacement of oxalate. Experiments in  $\text{H}_2\text{O}/\text{D}_2\text{O}$  solvent mixtures show that the rate of aquation increases as a function of deuterium atom fraction in agreement with the Gross-Butler equation. This finding is consistent with the proton pre-equilibration postulate. Some exchange experiments using carbon-14 labelled free oxalate  $-\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2^-$  ion mixtures indicate that oxalate exchange with the latter ion occurs at a negligible rate, even under conditions where exchange with  $\text{Cr}(\text{C}_2\text{O}_4)_3^{3-}$  ion is quite rapid. (auth)

## 12570

FREE ENERGIES OF FORMATION OF GASEOUS URANIUM, MOLYBDENUM, AND TUNGSTEN TRIOXIDES. R. J. Ackermann and R. J. Thorn (Argonne National Lab., Lemont, Ill.); Carl Alexander (Battelle Memorial Inst., Columbus, Ohio); and Marvin Tetenbaum (General Electric Co., Cincinnati). *J. Phys. Chem.* **64**, 350-5(1960) Mar.

The vapor density in equilibrium with  $\text{MoO}_3$  and  $\text{U}_3\text{O}_8$  was measured by means of the transpiration method with oxygen employed as a carrier gas. The standard free energy of sublimation in calories per mole of gas for  $\text{MoO}_3$  is given over the temperature range 980 to 1060°K by the equation  $\Delta F_g^\circ = (87.8 \pm 1.0) 10^3 - (73.0 \pm 1.0)T \text{ cal mole}^{-1}$ , in which the polymeric species in the vapor are recognized. In the case of  $\text{U}_3\text{O}_8$ , variation of the oxygen pressure in the carrier gas establishes the oxygen-to-uranium ratio equal to three for the volatile uranium oxide molecule. By a comparison with the entropies of sublimation of  $\text{MoO}_3$  and  $\text{WO}_3$  it is inferred that gaseous monomeric  $\text{UO}_3$  is the principal species produced by the reaction of  $\text{U}_3\text{O}_8$  with oxygen. Although the vapor may not consist entirely of monomer, the standard free energy of formation in calories per mole of this gas over the temperature range 1230 to 1700°K can be expressed by the equation  $\Delta F_f^\circ = -198,500 + 19.0T \text{ cal mole}^{-1}$ . (auth)

## 12571

DISTRIBUTION OF SILVER BETWEEN LIQUID LEAD AND ZINC. David T. Peterson and R. Kontrimas (Ames Lab., Ames, Iowa). *J. Phys. Chem.* **64**, 362-4(1960) Mar.

The distribution coefficient of silver between liquid zinc and lead was determined over a wide concentration range at three temperatures. The coefficient did not change with concentration. The enthalpy of transfer of silver from lead to zinc was -10.9 kcal. This agrees with the value calculated from the partial molar enthalpy of silver in liquid zinc and lead. (auth)

## 12572

THE ENTROPY OF SOLUTION OF IODINE AT CONSTANT

VOLUME. J. H. Hildebrand (Univ. of California, Berkeley). *J. Phys. Chem.* **64**, 370-1(1960) Mar.

Recent data on the partial molal volume of iodine and the entropy of expansion of solvents are used to calculate the partial molal entropy of solution of solid iodine at constant pressure ( $\Delta S_p$ ) and at constant volume ( $\Delta S_v$ ). Both  $\Delta S_p$  and  $\Delta S_v$  are plotted vs.  $-\text{R} \ln x_2$  ( $x_2$  solubility) for a series of non-interacting and nonpolar solvents at 25°C. The slope of the  $\Delta S_v$  line is 1.10, not too greatly different from the value of 1.00 expected from theoretical considerations for regular solutions. The intercept of the line extrapolated to the  $-\text{R} \ln x_2$  axis is 9.0 entropy units for the entropy of fusion of iodine at 25°C, not far from the 8.0 value extrapolated from the melting point of iodine and known heat capacities. (D.L.C.)

## 12573

PROTON NUCLEAR SPIN RESONANCE SPECTROSCOPY. XI. A CARBON-13 ISOTOPE EFFECT. George Van Dyke Tiers (Minnesota Mining & Mfg. Co., St. Paul). *J. Phys. Chem.* **64**, 373-4(1960) Mar.

The nuclear spin resonance shielding of C-H was determined in  $(\text{CH}_3)_4\text{Si}$ ,  $\text{CH}_3\text{I}$ ,  $\text{CH}_2\text{Cl}_2$ , and  $\text{CHCl}_3$  for the isotopes  $\text{C}^{12}$  and  $\text{C}^{13}$ . The difference in shielding for these isotopes,  $T_{13}-T_{12}$ , was +42, +12, +42, and +59  $\times 10^{-4}$  ppm for the respective compounds. This difference is of the same sign but only about  $1/40$  as large as the corresponding effect on fluorine. This factor,  $1/40$ , has also been observed for the deuterium isotope effect on proton and fluorine shieldings. (D.L.C.)

## 12574

THE STANDARD ELECTRODE POTENTIAL OF THE QUINHYDRONE ELECTRODE FROM 25 TO 55°. John C. Hayes and M. H. Lietzke (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.* **64**, 374-6(1960) Mar.

The standard electrode potentials of the quinhydrone electrode were measured from 25 to 55°C at 5° intervals, using a Ag-AgCl reference electrode. Then the activity coefficients of HCl at those temperatures were calculated from the data. The standard potentials agree within 0.1 mv, and the activity coefficients agree closely with earlier values. The largest deviations for the activity coefficients is less than 1% at 40 and 45°C. It is concluded that the quinhydrone electrode can be used in activity coefficient measurements in a manner similar to the hydrogen electrode. (D.L.C.)

## 12575

THE HEAT OF COMBUSTION OF THULIUM. Elmer J. Huber, Jr., Earl L. Head, and Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). *J. Phys. Chem.* **64**, 379-80(1960) Mar.

The heat of combustion of thulium was determined by combustion of a weighed sample in a bomb calorimeter at a known initial oxygen pressure. The heat of formation of  $\text{Tm}_2\text{O}_3$  is  $\Delta H_{25}^\circ = 1888.8 \pm 5.7 \text{ kJoules/mole}$  or  $451.4 \pm 1.4 \text{ kcal/mole}$ . (D.L.C.)

## 12576

THE THERMODYNAMICS OF THE REACTION  $\text{Cr}(\text{OH})_6^{+3} + \text{Br}^- = \text{Cr}(\text{OH})_5\text{Br}^{+2} + \text{H}_2\text{O}$  IN AQUEOUS SOLUTION OF IONIC STRENGTH = 2.0 M. James H. Espenson and Edward L. King (Univ. of Wisconsin, Madison). *J. Phys. Chem.* **64**, 380-1(1960) Mar.

The reaction  $\text{Cr}(\text{H}_2\text{O})_6^{3+} + \text{Br}^- = \text{Cr}(\text{H}_2\text{O})_5\text{Br}^{2+} + \text{H}_2\text{O}$  in aqueous solution of 2 M ionic strength was studied using an ion-exchange procedure. Equilibrated solutions were quenched and diluted in one operation and then passed through a Dowex-50 resin column. The chromium species



of charge 3+ was held in the resin phase while all species of lower charge were eluted. The eluant was analyzed for its chromium content and  $Q_1 = [\text{CrBr}^{2+}]/[\text{Cr}^{3+}][\text{Br}^-]$  was calculated, assuming the eluted species to be only  $\text{Cr}(\text{H}_2\text{O})_5\text{Br}^{2+}$ . The relative constancy of  $Q_1$  for various concentrations of  $\text{Br}^-$  at constant ionic strength (2M) supports this assumption and also indicates that the amount of  $\text{CrBr}_2^+$  species formed is inappreciable.  $Q_1$  is given for the temperatures 0.0, 25.0, 34.7, and 45.2°C, and  $\Delta H_1$  and  $\Delta S_1$  are found to be +5.1 kcal and +4.9 entropy units, respectively.  $Q_1$  at 25.0°C is  $2.25 \times 10^{-3}$ . (D.L.C.)

## 12577

ISOTOPE EFFECTS IN POLYMERIZATIONS OF CARBON-14-LABELED STYRENES. Ernest M. Hodnett and Arnold W. Jensen (Oklahoma State Univ., Stillwater). J. Polymer Sci. **43**, 183-91(1960) Mar.

Styrene- $\beta$ - $\text{C}^{14}$  was polymerized (1) thermally at 99°C, (2) with benzoyl peroxide at 51°C, and (3) with stannic chloride at 25°C. The  $\text{C}^{14}$ -labeled monomer was found to react (1) 91.8, (2) 91.5, and (3) 95.0% as fast as the nonradioactive styrene under these conditions. When styrene- $\alpha$ - $\text{C}^{14}$  was polymerized thermally at 99° and with stannic chloride at 25°C, the radioactive monomer reacted 97.0 and 100% as fast as nonradioactive styrene. These results are interpreted in terms of the propagation step of the reaction. (auth)

## 12578

QUANTITATIVE ANALYSIS BY X RAYS OF URANIUM AND URANIUM CARBIDE POWDERS OXIDIZED AT THE SURFACE. M. Pluchery (Centre d'Études Nucléaires, Grenoble, France). Planseeber. Pulvermet. **8**, 14-21 (1960) Apr. (In French)

An x-ray absorption method for determining the oxide thickness on spherical powders is described. In the most general case the contribution of a particle to the total intensity of a Bragg reflection is:  $I = K\varphi(\Theta) \cdot H(\Theta)$ .  $\Theta$  is the Bragg angle,  $\varphi$  accounts for various factors (polarization, structure factor, etc.) and  $H(\Theta)$  depends exclusively on the form of the particle. The ratio of the reflected intensity contributed by the uranium (or UC) core of the particle to the theoretical value is a function of the oxide thickness. It can be shown that this function, although the ratio of two discontinuous functions, can be interpolated into a continuous function. The oxide layer allows a similar treatment. From the comparison of the two interpolated functions the thickness of the oxide layer can be estimated under a very simple form. This allows extending the method to the case where the powder particles are of various sizes within a large range. The application of this method to standard samples of known oxide content yielded satisfactory results for thicknesses greater than 0.02  $\mu$ . Minute amounts of oxide are to be determined with an electron microscope method. Further experiments are being carried out for exploring the intermediate range. (auth)

## 12579

PRODUCTION OF PURE URANIUM CARBIDE BY CARBURATION OF URANIUM BY GASEOUS HYDROCARBONS ESPECIALLY METHANE. APPLICATION OF THE THERMOGRAVIMETRIC METHOD TO STUDY OF THE KINETICS OF THE REACTION. C. Moreau (Centre d'Études Nucléaires, Grenoble, France). Planseeber. Pulvermet. **8**, 22-7(1960) Apr. (In French)

Uranium monocarbide is preferably produced by one of the three following reactions:  $\text{U} + \text{C}$ ,  $\text{UO}_2 + \text{C}$ ,  $\text{U} + \text{hydrocarbons}$  (mainly methane). The latter reaction, which has been only scarcely investigated, shows a marked advantage

over the others, yielding uranium monocarbide in powder form. Kinetics of the reaction was examined by means of thermogravimetric methods. The reaction rate is fastest at 900°C with calcium reduced uranium powder. Raising the partial pressure of methane as well as decreasing the grain size of the uranium increases the reaction rate. In any case, a mixture of  $\text{UC} + \text{UC}_2$  is formed. These facts lead to a new method for producing pure UC. After the formation of a three-phase mixture of  $\text{U} + \text{UC} + \text{UC}_2$ , containing 4.8% C, the powder is heat-treated which leads to the reaction of free U with  $\text{UC}_2$ , thus giving pure UC as the end product. (auth)

## 12580

ABSORPTION AND LUMINESCENCE OF IMPURITIES IN ORGANIC COMPOUND CRYSTALS AT 20°K. III. NAPHTHACENE SPECTRA IN CRYSTALS OF CERTAIN PARAPOLYPHENYLS. A. V. Soloviov (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur. **4**, 615-28(1959) Sept.-Oct. (In Ukrainian)

Electronic absorption and luminescence spectra were obtained for naphthacene impurities in para-terphenyl and para-quaterphenyl crystals. A comparison is made of electron-oscillatory frequencies in spectra of naphthacene dissolved in a number of organic crystals. The question as to whether these frequencies of the solvents are affected with the changes set up in the electron states of the impurity molecule is discussed. It is shown that a slight deformation of the naphthacene molecule skeleton by the surrounding solvent crystal molecules is sufficient to explain the observed changes in the electron-oscillatory frequencies. It is noted that the greater the shift of the impurity spectrum toward the long waves, as compared with the spectrum of its vapors, the more indistinct the bands in the impurity spectrum became. (auth)

## 12581

FURTHER ANALYSIS OF THE SPECTRA OF TRIVALENT SAMARIUM IN SINGLE CRYSTALS OF DIFFERENT SYMMETRY. A. Friederich, K. H. Hellwege, and H. Lämmermann (Technische Hochschule, Darmstadt, Ger.). Z. Physik **158**, 251-60(1960). (In German)

The investigation of the absorption spectrum and Zeeman effects of the ethyl sulfate, chloride, and nitrate of trivalent samarium at low temperatures was made. Missing crystal field components of the ground term were determined and from these the magnetic specific heat of the salt was calculated. Two line groups in the visible spectral region were analyzed. (tr-auth)

## 12582

MAGNESIUM AND URANIUM IGNITION IN DIFFERENT GASEOUS ATMOSPHERES. R. Darras, P. Baque, and D. Leclercq (Commissariat à l'Énergie Atomique, Paris). p.53-69 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

The burning temperatures of magnesium, uranium, and some of their alloys were systematically determined in an air or carbon dioxide atmosphere, either dry or wet. Two different ways of heating were used: either continuously rising up the temperature, or heating to and then maintaining a constant temperature. The results are different in the two cases. If moisture has little effect on the magnesium burning temperatures in air, it does lower them by about 130 to 140°C in  $\text{CO}_2$ . The differences between the burning of magnesium and uranium were noticed; this leads to a distinction between an "ignition" and an "inflammation." (auth)

**12583**

Bureau of Mines.

CONTRIBUTIONS TO THE DATA ON THEORETICAL METALLURGY. XIII. HIGH-TEMPERATURE HEAT-CONTENT, HEAT-CAPACITY, AND ENTROPY DATA FOR THE ELEMENTS AND INORGANIC COMPOUNDS. Bulletin No. 584. K. K. Kelley. 1960. 247p. \$1.25(GPO).

High-temperature heat-content, heat-capacity, and entropy data are presented for the elements and their inorganic compounds. A selection of "best" values was made from available experimental and calculated values. The heat-content data are given in algebraic and tabular form. (B.O.G.)

## Analytical Procedures

**12584** CF-59-6-82

Oak Ridge National Lab., Tenn.

HEXONE EXTRACTION-COULOMETRIC TITRATION OF URANIUM. E. L. Blevins. June 22, 1959. 4p. OTS.

Samples containing 5 to 10 mg of uranium were extracted with hexone (methyl isobutyl ketone) and titrated coulometrically in sulfate media. Relative standard deviations of 0.43% for samples containing 5 mg and 0.56% for 10 mg were determined by precision studies. (auth)

**12585** DEGR-94(CA)

United Kingdom Atomic Energy Authority. Development and Engineering Group, Capenhurst, Ches., England. INCREASING THE RESOLVING POWER OF A METROPOLITAN-VICKERS M.S.2 MASS SPECTROMETER, WITH PARTICULAR REFERENCE TO ANALYSIS OF URANIUM HEXAFLUORIDE. R. Thorburn and E. J. Robbins. Jan. 25, 1960. 30p. BIS.

An investigation in which a mass spectrometer was used for measuring  $U^{234}$  and  $U^{236}$  concentrations in uranium hexafluoride is described. Discussions of the factors affecting the resolving power, and approximate values for the different aberrations which occur in this mass spectrometer are included. The increase in resolving power which enables measurements of the  $U^{234}$  and  $U^{236}$  concentrations to be made is brought about by reducing the lengths and widths of the collimator and collector slits. (auth)

**12586** DMIC-Memo-49

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

THE DETERMINATION OF OXYGEN, NITROGEN, HYDROGEN, AND CARBON IN MOLYBDENUM, TUNGSTEN, COLUMBIUM, AND TANTALUM. Manley W. Mallett. Mar. 31, 1960. 21p. (PB-161199). OTS.

A review of methods for determining interstitial oxygen, hydrogen, nitrogen and carbon in molybdenum, tungsten, niobium, and tantalum is presented. (J.R.D.)

**12587** HW-23228

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

ANALYTICAL APPLICATIONS OF REFRACTIVE INDEX. L. L. Burger. Jan. 9, 1952. Decl. Feb. 17, 1960. 10p. OTS.

The usefulness of refractive index as rapid analytical technique for  $Al_2(NO_3)_3$ ,  $UO_2(NO_2)_2$ ,  $Ca(NO_3)_2$ ,  $HNO_3$ , and  $NaNO_3$  solutions was investigated. (W.L.H.)

**12588** KAPL-M-DGM-5

Knolls Atomic Power Lab., Schenectady, N. Y.

COUNTING TECHNIQUES IN THE RADIOCHEMICAL

DETERMINATION OF U-235 FISSION BURN-UP. D. G. Miller. Mar. 11, 1960. 29p. Contract W-31-109-Eng-52. OTS.

The burn-up in  $U^{235}$  fuel samples was determined by a combined radiochemical and mass spectrometric technique. Total fissions were determined by a radiochemical measurement of fission product  $Cs^{137}$  using the cesium perchlorate method.  $U^{235}$  and  $U^{238}$  were determined by mass spectrometry using  $U^{233}$  as an internal standard. The determination of  $Cs^{137}$  was found to be limited by the presence of  $Cs^{134}$ , this limitation being a function of the flux energy spectrum to which the fuel was exposed. The calculated  $Cs^{134}/Cs^{137}$  ratio is presented as a function of burn-up for a thermal flux of  $C/F = 0.17$ . (C.J.G.)

**12589** NYO-2215

Pennsylvania State Univ., University Park. Coll. of Chemistry and Physics.

KINETICALLY DIFFERENTIATED ENTHALPY TITRATION CURVES. Special Report. Joseph Jordan and E. J. Billingham, Jr. Mar. 25, 1960. 21p. Contract AT(30-1)-2133. OTS.

When a soluble oxalate was titrated rapidly into a dilute solution of calcium in a borate buffer of pH 8, a well defined thermometric titration curve was obtained, corresponding to instantaneous exothermic precipitation of calcium oxalate. In contradistinction, the analogous titration curve of magnesium with oxalate was quasi-isothermal in shape due to a slow precipitation mechanism involving a complex intermediate. Based on these differences in kinetic behavior, a method has been developed for the determination of calcium in the presence of magnesium. The procedure involves an automatic thermometric titration with standard oxalate and has been adapted to the non-separative analysis of calcium in limestone and dolomite. It combines the advantages of a macro-technique in terms of sample size, with the convenience of a micro-titration procedure in the determinative step. (auth)

**12590** AEC-tr-4037

DETERMINATION OF ALCOHOLS USING THE ISOTOPIC DILUTION METHOD. V. Ya. Efremov, M. B. Neiman, and V. N. Panfilov. Translated by A. L. Monks (Oak Ridge National Lab.) from *Trudy Komissii Anal. Khim., Akad. Nauk S.S.S.R., Inst. Geokhim. i Anal. Khim.* 9, 361-6(1958). 7p. JCL or LC.

The principles of the isotopic dilution analysis of alcohols are discussed. The alcohols, after addition of a definite amount of labeled alcohol to the mixture containing unknown amounts of alcohol, were complexed with 3, 5-dinitrobenzoylchloride. After subsequent separation, the benzoates were subjected to a radiometric analysis. The method was applied to the determination of methyl and ethyl alcohols and found to have an error of less than 5%. (C.J.G.)

**12591**

DETERMINATION OF RARE EARTH METALS IN THEIR MIXTURE. A. Almásy (Hungarian Academy of Sciences, Budapest). *Acta Chim. Acad. Sci. Hung.* 17, 55-68(1958). (Translated from *Referat. Zhur. Khim.* No. 9, 1959, abstract No. 30995).

A method based on the sorption of rare earth elements (REE) by a Dowex-50 cationite, subsequent elution of REE with solutions of different pH values, quantitative determination of the separate components by means of oxalate precipitation, and smelting and weighing the residues obtained, is described. Dissolving < 200 mg of the mixture of REE oxides in HCl, sealing the solution in a glass ampule, and



activation of REE with a neutron source precede the breaking down of REE. The resulting solution is passed through a small ionite column, REE is introduced into the large column 2 m long and 1 cm in diameter, filled with Dowex-50 cationite with a granularity of 0.04 to 0.05 mm, and rinsed with ammonia and with the elutriating solution (ES). The relative rate of elutriation of REE changes by jumps within the limits of the narrow pH interval which occupies a different position for all the elements being studied. By gradually changing the pH of ES, consecutive extraction of the components of the mixture in the series of increasing ion radii is achieved. In the proposed method of stage chromatography, elutriation is carried out at 76°C and the ES used in this method consists of 1 M solutions of lactic acid with the addition of 0.1 mole/l of phenol, the pH of which is controlled by the passage of gaseous  $\text{NH}_3$ . At first ES with pH 3.00 is passed through the column at the rate of 5 ml/min and the activity of the elutriate is continuously measured. Upon attaining the maximum activity in the last element being extracted by the given ES, one begins to pass through the next ES with a higher pH value. Simultaneously the receiver for collecting the fractions of the elutriate is changed. The first ES with pH 3.00 extracts Sc, Lu, Yb; the 2nd (pH 3.05) extracts Tm, Er, Ho; the 3rd (pH 3.10) extracts Y, Dr, Tb; the 4th (pH 3.15) extracts Cd, Eu; the 5th (pH 3.25) extracts Sm (Pm); the 6th (pH 3.30) extracts Nd, Pr; the 7th (pH 3.44) extracts Ce; and the 8th (pH 3.50) extracts La. Each fraction of the elutriate is examined by x-ray method for REE content and then used for separation by oxalate precipitation of the elements being determined. Fractions of similar composition are united prior to the addition of the precipitating agent. The precipitate is set out for 24 hours, then filtered and flushed with 0.5 M  $\text{H}_2\text{SO}_4$  solution, saturated with oxalic acid. Then it is annealed at 1000°C and weighed. The method is used for quantitative analysis of different mixtures of REE. In the opinion of the authors this method can be utilized for determination of the ions of 3-valence actinides in their mixtures.

#### 12592

CHROMATOGRAPHY. Harold H. Strain (Argonne National Lab., Lemont, Ill.). *Anal. Chem.* **32**, 3R-18R(1960) Apr.

A review of fundamental developments in the field of chromatography is presented. Approximately 450 references are cited. The differential migration methods discussed are: electro-, gas, and solution chromatography; mass spectrometry; thermal gravitational diffusion; multiple partition; sedimentation; and diffusion. These methods are grouped according to the physical condition of the mixture of substances for detection, separation, estimation, and/or isolation. (B.O.G.)

#### 12593

NUCLEONICS. W. Wayne Meinke (Univ. of Michigan, Ann Arbor). *Anal. Chem.* **32**, 104R-36R(1960) Apr.

A review of publications in nucleonics is given from late 1957 to late 1959 and follows without overlapping material given in previous reviews. This includes discussions of general aspects, radioisotopes as sources and tracers, instrumentation and measurement, safety, and training in nuclear techniques. 1059 references. (B.O.G.)

#### 12594

THE SEPARATION AND DETERMINATION OF ALUMINUM IN PLUTONIUM-ALUMINUM ALLOYS. F. J. Miner, R. P. Degrazio, C. R. Forrey, Jr., and T. C. Jones (Dow Chemical Co., Denver). *Anal. Chim. Acta* **22**, 214-20(1960). (In English)

An anion-exchange method was given for the separation of aluminum from plutonium in a 1% aluminum-plutonium

alloy. After separation, the aluminum is determined using oxine, either volumetrically or gravimetrically, or by a complexometric titration using EDTA. The volumetric methods are faster. On synthetic alloy samples containing 5.00 mg of aluminum and 500 mg of plutonium, the mean recovery and the standard deviation of the volumetric oxine method are 4.93 mg and  $\pm 0.08$  mg, respectively. Using the EDTA procedure, the comparable values are 4.92 mg and  $\pm 0.10$  mg, respectively. Of the elements commonly present as impurities only nickel interferes, but the volumetric procedures can be modified so that this interference is eliminated. (auth)

#### 12595

THE POLAROGRAPHIC DETERMINATION OF SMALL AMOUNTS OF TIN AND LEAD IN ZIRCONIUM AND ITS ALLOYS. R. T. Clark (Imperial Chemical Industries, Ltd., Birmingham, Eng.). *Analyst* **85**, 245-9(1960) Apr.

A direct polarographic method is described for the simultaneous determination of from 10 to 200 ppm each of tin and lead in zirconium and Zirconium MV/ATR (an alloy containing 0.5% each of copper and molybdenum). The height of the single polarographic wave produced by the combined effect of lead and tin is measured, the diffusion current produced by lead is then suppressed by co-precipitating lead as sulphate, and the resulting wave height produced by tin alone is measured. Interference from copper and molybdenum is prevented by precipitating these elements as ferrocyanides. The method is simple and rapid and should be applicable to many different metallurgical materials. (auth)

#### 12596

THE RAPID RADIOCHEMICAL DETERMINATION OF CAESIUM-137. Noboru Yamagata and Toshiko Yamagata (Gunma Univ., Kiryu, Japan). *Analyst* **85**, 282-5(1960) Apr.

A method is described for the rapid radiochemical determination of caesium-137 in various materials containing 0.1 g or less of potassium. The first step is scavenging with ferric hydroxide (or phosphate), the second is precipitation of caesium with potassium dipicrylamine and the third is re-precipitation of caesium as chloroplatinate. The beta-particle activity of the final precipitate (4 to 15 disintegrations per minute) is counted by a low-level counting system. The combined contribution of the activities of potassium-40 and rubidium-87 is less than 0.2 disintegration per minute, and decontamination factors for other fission activities are greater than  $10^4$ . The method can be applied to the determination of caesium-137 in 50-g wet samples of human tissue or in 10-g samples of bone. (auth)

#### 12597

ISOTOPIC DETERMINATION OF LITHIUM BY NEUTRON ACTIVATION. R. F. Coleman (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). *Analyst* **85**, 285-8(1960) Apr.

A method is given for determining the isotopic abundance in lithium samples. A solution of lithium hydroxide is irradiated in the neutron flux of a reactor, and the activity of the fluorine-18 produced by the reactions  $\text{Li}^6(n,t)\text{He}^4$  and  $\text{O}^{16}(t,n)\text{F}^{18}$  is measured in a positron counter. The error of the method is 1 to 2%, which makes it particularly suitable for the analysis of samples from a small research separation apparatus. (auth)

#### 12598

ZONE REFINING AND CHEMICAL ANALYSIS OF KCl AND KBr. Scott Anderson, John S. Wiley, and Lloyd J.

Hendricks (Anderson Physical Lab., Champaign, Ill.). *J. Chem. Phys.* **32**, 949-50(1960) Mar.

The results of zone refining and neutron activation analysis of KBr and KCl are presented. (C.J.G.)

#### 12599

RADIOASSAY BY GAS CHROMATOGRAPHY OF COMPOUNDS LABELLED WITH CARBON-14. Arthur Karmen and Harold R. Tritch (National Heart Inst., Bethesda, Md.). *Nature* **186**, 150-1(1960) Apr. 9.

An efficient device is described for trapping materials from the effluent of a gas chromatographic column which facilitates collection of components labeled with carbon-14 in close proximity to an efficient scintillator. Collection of components from aliquots of carrier gas into separate traps for subsequent counting affords a sensitivity of carbon-14 assay limited only by the sensitivity of liquid scintillation counting technique. Continuous scintillation counting of a single trap through which the column effluent flows permits the high resolution and convenience afforded by simultaneously recording component elution and radioactivity. Applications are described in the radioassay of fatty acid esters. (C.H.)

#### 12600

ANALYSIS OF ZIRCONIUM-TUNGSTEN, HAFNIUM-TUNGSTEN, AND THORIUM-TUNGSTEN ALLOYS AND ALSO THORIATED AND ZIRCONIATED TUNGSTEN BY EDTA TITRATION. E. Lassner and R. Scharf (Metallwerk Plansee A. G., Reutte, Tirol, Austria). *Planseeber. Pulvermet.* **8**, 37-9(1960) Apr. (In German)

A new method for the EDTA titration of zirconium, hafnium, and thorium and their respective oxides in tungsten is described. The method requires little time and yields results of high accuracy. (auth)

#### 12601

SPECTROGRAPHIC DETERMINATION OF Hf-Zr RATIOS. G. Rossi (Centro Informazioni Studi Esperienze, Milan). *Spectrochim. Acta* **16**, 25-9(1960) Feb.

A spectrographic method is described for determining hafnium in zirconium. With a single exposure it is possible to cover the weight ratios of Hf/Zr from 0.001 to 1. The oxides mixed with a buffer are excited by a d-c 20-amp arc and the spectrum recorded with a large quartz prism spectrograph. The hafnium concentration is determined from the intensity ratio of the line pairs Hf II 2641.4/Zr II 2856.06 and Hf I 2779.36/Zr I 2792.04 with coefficients of variation = 2.6 and 1.97%, respectively. (auth)

#### 12602

STUDIES IN BIVALENT CHROMIUM SALTS. PART VII. ESTIMATION OF BIVALENT TIN, HEXAVALENT URANIUM, AND PENTAVALENT VANADIUM. J. P. Tandon and R. C. Mehrotra. *Z. anal. Chem.* **164**, 314-19(1958). (Translated from *Referat. Zhur. Khim.* No. 13, 1959, abstract No. 45499).

Titrimetric procedures were developed for the determination of Sn(2+), UO<sub>2</sub>(2+), and VO<sub>3</sub><sup>-</sup> by the utilization of CrSO<sub>4</sub> as the titrant.

#### 12603

THE ANALYTICAL CHEMISTRY OF ZIRCONIUM. I. SOLOCHROME VIOLET R AS AN INDICATOR FOR THE MICRO- AND MACRO-TITRATION OF Zr WITH COMPLEXONE III. J. Korkisch and A. Farag. *Z. anal. Chem.* **165**, 6-10(1959). (Translated from *Referat Zhur. Khim.* No. 13, 1959, abstract No. 45539).

A rapid method was developed for the complexometric

titration of Zr with complexone III solution using Solochrome Violet R (1-[3-hydroxy-1-naphthylazo]-2-hydroxybenzene-5-sulfonic acid) as indicator.

#### 12604

ANALYTICAL APPLICATIONS OF SOME ORGANIC ACIDS. PART II. GRAVIMETRIC DETERMINATION OF ZIRCONIUM BY *m*-PHENYLENEDIOXYDIACETIC ACID. C. S. Pande and T. S. Srivastava. *Z. anal. Chem.* **165**, 343-7(1959). (Translated from *Referat. Zhur. Khim.* No. 13, 1959, abstract No. 45540).

It has been established that phenyldioxydiacetic acid (I) forms a water-insoluble compound with Zr in the presence of NH<sub>4</sub>NO<sub>3</sub>; the product separates out in the form of a curdled flesh-colored precipitate. Quantitative precipitation of Zr takes place at acidities  $\leq 0.1$  N. The precipitate does not have a constant composition and the Zr is therefore determined after ignition of the precipitate to ZrO<sub>2</sub>. Cu(2+), Be(2+), Mg(2+), Ca(2+), Zn(2+), Cd(2+), Pb(2+), UO<sub>2</sub>(2+), and Mn(2+) do not interfere with the determination of Zr. For the elimination of interference by Al(3+), Ce(3+), Cr(3+), Ti(4+), and Fe(3+) the precipitate obtained is dissolved in 1:1 HNO<sub>3</sub>, the excess (over 0.08 N) of acid is neutralized with NaOH, and the precipitation is repeated. Sn(2+), Sn(4+), Th(4+), and V(4+) interfere with the determination.

#### 12605

THE DIRECT SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM QUANTITIES OF COPPER IN HIGH-PURITY URANIUM WITH OXALDIHYDRAZIDE. D. D. Stevancevic. *Z. anal. Chem.* **165**, 348-54(1959). (Translated from *Referat. Zhur. Khim.* No. 13, 1959, abstract No. 45512).

Two variants of a spectrophotometric procedure for the determination of microgram quantities of Cu in high-purity uranium with oxaldihydrazide were developed and are described.

#### 12606

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires.

MÉTODO RÁPIDO PARA LA DETERMINACIÓN ESPECTROSCÓPICA DE TIERRAS RARAS EN MONACITAS Y COMPUESTOS DE CERIO. Informe No. 25. (Rapid Method of Spectroscopic Determination of Rare Earths in Monazites and Cerium Minerals). Report No. 25. Olga Brieux de Mandirola. 1959. 13p.

A d-c spectroscopic method was developed for the determination of the rare earth elements in monazites and related cerium minerals. It employs a Hilger model E 492 quartz spectrograph and barium nitrate as a spectroscopic buffer. No previous chemical separations are necessary. The accuracy for the determination of every rare earth element except terbium is  $\pm 10\%$ . (auth)

## Radiation Chemistry

#### 12607 TID-5797

Michigan. Univ., Ann Arbor. Michigan Memorial-Phoenix Project.

RESONANCE IN RADIATION EFFECTS. Technical Report No. 1. Henry J. Gombert, Marvin C. Atkins, William R. Clendinning, Ardath H. Emmons, Julian L. Garson, and Adon A. Gordus. Feb. 1960. 42p. Contract AT(11-1)-684. (MMPP-03049-1-T). OTS.

The extent of radiation damage in various compounds due to monochromatic x rays at 5 to 35 kev was investi-



gated. The effects of monochromatic radiation on solid solutions containing  $\text{CHI}_3$ ,  $\text{CBr}_4$ , and  $\text{C}_2\text{Cl}_6$  were studied. The effects of diffracted x radiation and x-ray-fluorescent irradiation on catalase (in solution and dry) were analyzed. The radiation damage produced in the liquid n-butyl bromide system containing diphenylpicrylhydrazyl by fluorescent x radiation was studied. (C.J.G.)

#### 12608 AEC-tr-3894

POLYMERIZATION OF ETHYLENE UNDER THE INFLUENCE OF GAMMA-RADIATION. (Polimerizatsiya Etilena pod Vliyaniem Gamma-Izlucheni). S. S. Medvedev, A. D. Abkin, and P. M. Knomikovskii. Translated from a paper presented at the International Conference of High Energy Sources of Radiation, Warsaw, September 8-12, 1959. 22p. OTS.

An investigation of the polymerization rate of ethylene under the influence of gamma radiation in solutions and in gaseous state and at various concentrations of ethylene was conducted. Characteristics of the polymer after various processing conditions were also examined. While no detailed analysis can be made on data obtained thus far, the conclusion can be drawn that radiation promoted polymerization is a promising method for determining process velocities, radiochemical yields, and for establishing characteristics of the polymer. (J.R.D.)

#### 12609

THE USE OF THE RECOIL ENERGY OF FISSION PRODUCTS IN RADIATION CHEMISTRY. Paul Harteck (Rensselaer Polytechnic Inst., Troy, N. Y.). Atti Congr. sci. Rassegna intern. elettronica e Nucleare 6<sup>a</sup>, Rome, 3, 1959, p.5-25. (In English)

Experiments are described which were performed to investigate the use of fission recoils in nitrogen fixation. Experiments with  $\text{UO}_2$  powder in static systems showed that the path length was not sufficient and only 10% of the fission energy was released in the gas phase. The reactivity of  $\text{UF}_6$  makes it impractical. Glass fibers incorporating fissionable material were used in most of the experiments. A nitrous oxide dosimeter which was developed is described. Using an ionization spectrometer and a U glass fiber loop in the Brookhaven reactor, the kinetics of the  $\text{N}_2\text{-O}_2$  system was investigated. Some conclusions are made regarding economic feasibility of nitrogen fixation by a reactor. (T.R.H.)

#### 12610

RADIOINDUCED PEROXIDATION OF HYDROCARBONS. M. Durup, J. Durup, and M. Magat (Faculté des Sciences, Paris). Atti Congr. sci. Rassegna intern. elettronica e nucleare 6<sup>a</sup>, Rome, 3, 1959, p.27-41. (In French)

The use of radiation in industrial hydrocarbon oxidation processes is discussed. After presenting generalities on such reactions, specific consideration is given to chain peroxidation of cumene and chainless or short-chain peroxidation. It is concluded that radiation-initiated oxidation processes can produce hydroperoxides by reactions with long chains at low temperatures, and in reactions with short chains at moderate temperatures partially oxygenated compounds such as ketones, aldehydes, and alcohols can be produced. (T.R.H.)

#### 12611

MECHANISMS OF RADIATION DAMAGE TO AROMATIC HYDROCARBONS. John G. Burr (Atomics International Div., North American Aviation Co., Canoga Park, Calif.). Atti Congr. sci. Rassegna intern. elettronica e nucleare 6<sup>a</sup>, Rome, 3, 1959, p.43-64. (In English)

Experiments are reported which support the idea that the

addition process is predominant in decomposition of energized states of aromatic molecules. The problem resolves itself into how the observed H product is formed. A number of selectively deuterated biphenyls were irradiated. The results show that the formation of  $\text{H}_2$  is influenced by the zero point energy difference between C-H and C-D bonds. A bimolecular process is suggested:  $\text{C}_{12}\text{H}_{10} + \text{irradiation} \rightarrow \text{C}_{12}\text{H}_9 + \text{H}_2$ ;  $\text{C}_{12}\text{H}_9 + \text{C}_{12}\text{H}_{10} \rightarrow 2\text{C}_{12}\text{H}_9 \rightarrow (\text{C}_{12}\text{H}_9)_2$ . (T.R.H.)

#### 12612

SOME RECENT ADVANCES IN THE STUDY OF IRRADIATED POLYMERS. A. Charlesby (Royal Military Coll. of Science, Shrivenham, Eng.). Atti Congr. sci. Rassegna intern. elettronica e nucleare 6<sup>a</sup>, Rome, 3, 1959, p.87-95 (In English)

Some of the more unusual aspects of radiation studies on polymeric materials are briefly outlined, and the value of such work in solid state physics, surface chemistry, and radiobiology is pointed out. (T.R.H.)

#### 12613

THE IRRADIATION OF POLYPHENYLS WITH DIFFERENT TYPES OF RADIATION. W. G. Burns (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Atti Congr. sci. Rassegna intern. elettronica e nucleare 6<sup>a</sup>, Rome, 3, 1959, p.97-117. (In English)

Biphenyl, the three terphenyls, and Santowax R were irradiated with 1-Mev electrons at 300 to 400°C. The results are tabulated and discussed in comparison with results from reactor irradiations. The experiments show large G value variations with the LET of the radiation. (T.R.H.)

#### 12614

ISOTOPIC EFFECT OF HYDROGEN IN THE IRRADIATION AND THE THERMAL DECOMPOSITION OF DIPHENYL. J. M. Rayroux and P. Baertschi (Reacteur S. A., Würenlingen, Switzerland and Ecole Polytechnique Fédérale, Zürich). Helv. Chim. Acta 43, 484-9(1960). (In French)

The radiation stability and the thermal stability of ordinary ( $\text{C}_{12}\text{H}_{10}$ ) and deuterio ( $\text{C}_{12}\text{D}_{10}$ ) diphenyl were measured and compared. Deuterodiphenyl is more stable than the ordinary diphenyl by a factor of about 2, for pyrolysis at 460°C as well as for radiolysis at 30 to 40°C and at 310°C. This difference is of practical importance for the consideration of deuterodiphenyl as coolant for power reactors. (auth)

#### 1.615

PRODUCTS OF  $\gamma$ -IRRADIATION OF CYSTEINE AND CYSTINE. Pericles Markakis and A. L. Tappel (Univ. of California, Davis). J. Am. Chem. Soc. 82, 1613-17(1960) Apr. 5.

Cysteine and cystine in aqueous acidic solutions were exposed, in the absence and presence of oxygen, to  $\gamma$ -irradiation, at doses varying from  $10^4$  to  $8 \times 10^7$  rad. Cystine, hydrogen sulfide, free sulfur, sulfate ion, ammonia, and alanine were identified and determined among the irradiation products of cysteine; more than 80% of the sulfur and more than 90% of the nitrogen of cysteine could be accounted for. Qualitatively, the irradiated cystine solutions did not differ essentially from the irradiated cysteine solution; however, more free sulfur, sulfate ion and ammonia, less hydrogen sulfide, and very little cysteine were produced from cystine. Mechanisms for the radiolysis of these amino acids are discussed. (auth)

#### 12616

RADIOLYSIS AND BOND STABILITY OF SQUALANE.

Hideo Yamazaki and Shoji Shida (Tokyo Inst. of Tech.). *J. Chem. Phys.* **32**, 950-1 (1960) Mar.

The gaseous products from the radiolysis of squalane, ( $C_{30}H_{62}$ ) were studied. The G values and relative retention time of the gaseous products were determined. The bond energies in the squalane molecule were calculated by the Brown Method. (C.J.G.)

# 12617

AN ELECTRON SPIN RESONANCE STUDY OF A  $\gamma$ -IRRADIATED SINGLE CRYSTAL OF GLYCOLIC ACID. N. M. Atherton and D. H. Whiffen (Univ. of Birmingham, Eng.). *Mol. Phys.* **3**, 1-15 (1960) Jan.

Measurements were made of the electron spin resonance spectrum of a  $\gamma$ -irradiated single crystal of glycolic acid as a function of crystal orientation. These confirm that the trapped radicals are carboxy hydroxy methyl radicals,  $HO\dot{C}HCOOH$ . The results are expressed in the form of a spin Hamiltonian which includes a coupling tensor for the hydrogen attached to the central carbon atom and a tensor for the hydroxyl hydrogen. A special feature of the spectra is that the relative intensities of the hyperfine lines are non-integral, and this is explained by a derivation of the transition moments which shows that the usual selection rule  $\Delta M_I = 0$  is inapplicable to the solid state. The anisotropic g tensor is also evaluated. The tensors are briefly discussed in relation to the orientation of the radicals in the crystal and their electronic structure. (auth)

# 12618

EPR CHARACTERIZATION OF RADICALS IN IRRADIATED TETRA-*n*-BUTYL AMMONIUM HALIDES. E. L. Burrell, Jr. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). *J. Chem. Phys.* **32**, 955-6 (1960) Mar.

The electron paramagnetic resonance (EPR) spectra of radicals in irradiated tetra-*n*-butyl ammonium iodide and tetra-*n*-butyl ammonium bromide were determined. Both spectra were identical. The spectroscopic splitting factor for both irradiated compounds was found to be  $2.0024 \pm 0.003$  by comparison with 1,1-diphenyl-2-picrylhydrazyl. (C.J.G.)

# 12619

EFFECTS OF ETHYLENE, HYDROGEN AND RADIATION DOSAGE ON THE TRITIATED PRODUCTS RESULTING FROM THE  $He^3(n,p)H^3$  REACTION IN GASEOUS HYDROCARBONS. Myran C. Sauer, Jr., and John E. Willard (Univ. of Wisconsin, Madison). *J. Phys. Chem.* **64**, 359-62 (1960) Mar.

The yields of HT and of the tritiated hydrocarbons through  $C_8$  produced by the neutron irradiation of mixtures of  $He^3$  with methane, ethane, and propane were determined in the presence and absence of added ethylene and of hydrogen, and under different intensities of ionizing radiation. The results indicate that the thermal tritium atoms are effectively scavenged by ethylene with a resultant increase in the yield of tritiated butane and other products which may be formed by combination of  $C_2H_4T$  radicals with other radicals. Added  $H_2$  increases the yield of HT and decreases that of tritiated chain lengthened products. Tests were made of the effects of radiation intensity and dose. (auth)

# 12620

KINETICS OF RADICAL TERMINATION IN IRRADIATED POLYAMIDES. Joseph Zimmerman (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). *J. Polymer Sci.* **43**, 193-9 (1960) Mar.

The rate of decay of free radical concentration in irradiated polyamides was measured by observing the changes in

transient optical density of polyamide films at the wavelength of maximum absorption. The dependence of initial radical concentration and of the initial rate constant for radical decay on radiation dose is interpreted as resulting from the nonhomogeneous placement of radical "spurs" at low doses. The results are consistent with a "spur" diameter of 30 to 40 Å. (auth)

# 12621

MOLECULAR WEIGHTS OF RADIATION-FORMED POLYMETHYL METHACRYLATE. J. Dobó and L. Kiss (Research Inst. for the Plastics Industry, Budapest). *J. Polymer Sci.* **43**, 277-9 (1960) Mar.

Intrinsic viscosity and % conversion of the radiation-induced polymerization of methyl methacrylate were investigated for x irradiation rates of 41.90, 21.75, and 10.80 kr/hr at 25°C and periods of exposure ranging from 1 to 7 hours. No gel effect was observed for conversions below 13 to 15%, and the intrinsic viscosity remained constant. The effects of dark reaction at 45°C after irradiation were also studied; the conversion changed only slowly, but the intrinsic viscosity increased rather rapidly and there was a definite shift toward higher molecular weights. The activation energy was determined to be 4.34 kcal/mole between 25 and 45°C, in good agreement with previous results. The rate of reaction at 45°C is 1.58 times that at 25°C, whereas the increase in molecular weight is only 1.36-fold. (D.L.C.)

# 12622

ELECTRON SPIN RESONANCE STUDIES OF THE OXYGEN EFFECT OF IRRADIATED POLYTETRAFLUOROETHYLENE. Teikichi Matsugashita and Kenichi Shinohara (Japanese Assn. for Radiation Research on Polymers, Tokyo). *J. Chem. Phys.* **32**, 954-5 (1960) Mar.

The electron spin resonance spectra of irradiated polytetrafluoroethylene (PTFE) was examined at 9400 Mc/sec relative to the oxygen effect. Upon addition of air to the sample, the signal of the original PTFE radicals disappeared and an intense signal of the oxygenated radicals developed almost immediately. (C.J.G.)

# 12623

RADIOCHEMICAL ALTERATIONS IN POLYVINYL CHLORIDE UNDER THE EFFECT OF  $Co^{60}$  GAMMA RADIATION. L. Wuckel (Institut für angewandte Physik der Reinstoffe, Dresden). *Naturwissenschaften* **47**, 109-10 (1960) Mar. 1. (In German)

The role of air oxygen in the radiochemical changes of polyvinyl chloride was investigated. A polyvinyl chloride emulsion polymeride with a K value of 60 to 65 was used as a sample. It was radiated in the form of powder, films, and massive cylinders in high vacuum and in air. The total viscosity of the powders undergoes, after irradiation in vacuum, a slight deterioration at doses up to  $5 \times 10^6$  r, but at higher doses a lattice-like polymerization occurs. In irradiation in air the color of the sample does not vary, but in vacuum a brown color occurs. The behavior of massive cylinders is quite different from that of powders after irradiation. There is no variation in the total viscosity after irradiation in air and vacuum. Decomposition was observed up to doses of  $5 \times 10^5$  r, then an increasing lattice-life polymerization and insolubility occurred. A red color is observed after doses of  $3 \times 10^5$  r and it deepens with increasing irradiation doses. Film irradiated in air was not colored, but coloration occurred in vacuum irradiation. (J.S.R.)

# 12624

IRRADIATION REACTIONS IN HYDROCARBON GASES.



Frederick W. Lampe (Humble Oil and Refining Co., Baytown, Tex.). *Nucleonics* 18, No. 4, 60-65(1960) Apr.

The irradiation of gaseous hydrocarbon systems with 2-Mev electrons was investigated by observing chemical changes at various temperatures, pressures, and radiation intensities. G-values, molecules formed per 100 ev absorbed, were found for the irradiations of methane, ethylene, neopentane, argon-ethylene systems, and ethylene-propane systems. Argon transfers energy (charge or excitation) to ethylene with little or no change in the course of reaction. Indications are that a chain formation of pentane consistent with free-radical mechanism occurs during the irradiation of ethylene-propane mixtures at high temperatures and pressures. (B.O.G.)

#### 12625

PARAMAGNETIC DEFECTS IN IRRADIATED  $\text{KClO}_4$ . Terry Cole (Ford Motor Co., Dearborn, Mich.). *Proc. Natl. Acad. Sci. U. S.* 46, 506-9(1960) Apr.

Electron magnetic resonance studies of x-ray damaged crystals of potassium perchlorate indicate the presence of two types of stable paramagnetic defects at room temperature. One type of defect appears to be a trapped  $\text{ClO}_2$  molecule. Findings are described. (C.H.)

#### 12626

EFFECT OF ELECTRONS ON NATURAL ORGANIC COMPOUNDS IN THE ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION CAMERA. E. M. Belavtseva (Electron Microscopy Lab., Academy of Sciences, USSR). *Soviet Phys.-Cryst.* 4, 393-5(1960) Mar.

A study was made of the effect of electrons on crystals of  $\beta$ -carotin, chlorophyll, gramicidin, and iodine-gramicidin in the electron microscope and the electron diffraction camera. Iodine-gramicidin was found to be the least stable and carotin the most stable. During irradiation there was first a loss in crystallinity then a change in solubility to an insoluble state. From this investigation, the change in solubilities and absorption spectra of the compounds evidently occurs as a result of the ionizing effect of the electrons, since heating in a vacuum fails to give similar results. (B.O.G.)

## Raw Materials and Feed Materials

#### 12627 BKC-3596 and Add.

Blaw-Knox Construction Co. Chemical Plants Div., Pittsburgh.

THE DESIGN OF A DENITRATION REACTOR FOR UNITED STATES ATOMIC ENERGY COMMISSION, NEW YORK OPERATIONS OFFICE. Jan. 8, 1951. Decl. Mar. 2, 1960. 60p. Addendum, Jan. 31, 1951. OTS.

The proposed design features of a prototype denitration reactor are described in detail. Reduction of  $\text{UO}_3$  to metal and reactor burner capacity are also discussed. (J.R.D.)

#### 12628 CCCC-598

Catalytic Construction Co., Philadelphia. TECHNICAL DATA BOOK. FEED MATERIALS PRODUCTION CENTER, FERNALD, OHIO. PART XXII. JOB NO. 3000. Feb. 24, 1953. Decl. Mar. 7, 1960. 62p. Contract AT(30-1)-1060. OTS.

The Technical Data Book compiles useful chemical and physical data of feed materials, chemicals, uranium intermediates, and end products of the FMPC, Fernald, Ohio. The data presented encompass the process operations involved in the original integrated FMPC project, the uranium hexafluoride reduction plant, and the thorium plant. (auth)

#### 12629 GAT-P-15

Goodyear Atomic Corp., Portsmouth, Ohio.

CLEAN-UP REACTOR DUST SEPARATION INTERIM REPORT. M. L. Geneva, B. W. Penland, and E. H. Tepper. Jan. 25, 1960. 10p. Contract AT(33-2)-1. OTS.

One of the major problems in the operation of the clean-up reactor at the  $\text{UF}_4$ - $\text{UF}_6$  Conversion Facility has been plugging of the filter used to separate entrained powder from the process gases. A long-term program has been initiated to develop a system which would extend the life of the filter. Rearrangement of system components has resulted in an increased filter life and recent filter change-outs have been reduced to one per month. Additional modifications are planned to increase the life still further. (auth)

#### 12630 K-739

Carbide and Carbon Chemicals Div. K-25 Plant, Oak Ridge, Tenn.

URANIUM HEXAFLUORIDE PURIFICATION. A. L. Allen and E. W. Powell. Mar. 30, 1951. Decl. Mar. 2, 1960. 11p. Contract W-7405-eng-26. OTS.

An experimental batch distillation column was used to purify  $\text{UF}_6$  containing metal impurities. The degree of purification was determined by comparing the spectrographic analyses of the  $\text{UF}_6$  distillate material with the original feed or pot material. Results are tabulated at 95% confidence limits. (auth)

#### 12631 K-966

Carbide and Carbon Chemicals Co. K-25 Plant, Oak Ridge, Tenn.

LARGE SCALE TESTS OF THE AQUEOUS HYDROGEN FLUORIDE PROCESS FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE. G. J. Vogel. Oct. 10, 1952. Decl. Mar. 2, 1960. 15p. Contract W-7405-eng-26. OTS.

The conversion of  $\text{UO}_2$  to  $\text{UF}_4$  on a batch scale has demonstrated the value of the batch aqueous HF process. The product can be fed to the hydrofluorination trays for further drying or a dried product can be obtained which can be fed directly to the fluorination tower. Batches of from 400 to 1,000 lb were prepared in a modified rotary dryer to demonstrate the feasibility of a large scale process. (J.E.D.)

#### 12632 K-1008

Carbide and Carbon Chemicals Co. K-25 Plant, Oak Ridge, Tenn.

A CONTINUOUS PROCESS FOR CONVERTING URANIUM DIOXIDE TO URANIUM TETRAFLUORIDE USING AQUEOUS HYDROGEN FLUORIDE. S. D. Schiffman and L. H. Lett. Apr. 10, 1953. Decl. Mar. 2, 1960. 14p. Contract W-7405-eng-26. OTS.

A continuous process for converting  $\text{UO}_2$  to  $\text{UF}_4$  with aqueous HF has been developed. Over 98% conversion was obtained in a 4 gallon reactor at feed rates up to 24 pounds per hour using a 10% stoichiometric excess of 32% acid at slurry temperatures of 80 or 100°C. The reaction can be controlled easily; only 2 BTU/minute need be removed by cooling water when reacting 24 pounds per hour of  $\text{UO}_2$  with 32% acid at 100°C. Corrosion of the Hastelloy B reactor at these conditions is negligible. (auth)

#### 12633 MCW-1391

Mallinckrodt Chemical Works, St. Louis.

THE RECOVERY OF IONIUM AND URANIUM FROM RAFFINATE. R. D. Piper and W. A. Crump. Apr. 1, 1957. Decl. Feb. 5, 1960. 40p. Contract W-14-108-Eng-8. OTS.

A process was developed for recovering ionium ( $\text{Th}^{230}$ ) from Mallinckrodt raffinate cakes and was transferred to a pilot plant operation. Laboratory work involved in the development of the process is presented. (W.L.H.)

**12634** NP-8510

Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa.

MONTHLY REPORT DEVELOPMENT FOR FEBRUARY 1960. 16p. (D-60-2).

The carbonate leaching of Beaverlodge weekly leach feed samples, mine samples, and "C" and "L" samples is reported. An audio-frequency induced-current conductivity probe was used to measure deliberate changes of caustic concentration in solutions containing common salts of an alkaline leach circuit pregnant solution. The urea precipitation of ADU, effect of preheating ADU prior to reduction, and formation of ADU pellets were investigated in the ceramic oxide development. A study of relations between grain size sintered densities and specific surface areas of ceramic grade  $UO_2$  was initiated. (For preceding period see NP-8421.) (W.L.H.)

**12635** TID-5750

Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.

THE USE OF A FLUIDIZED BED REACTOR FOR THE CONTINUOUS PRODUCTION OF URANIUM TRIOXIDE.

W. C. Philoon, E. F. Sanders, and W. T. Trask.

[1960?]. 19p. Contract [W-14-108-eng-8]. OTS.

A program for development of a low-cost continuous process to produce uniform uranium trioxide from uranyl nitrate solution is described. A fluid bed reactor was developed and demonstrated for this purpose. Internal heat transfer tubes occupying one-third of the reactor cross section allowed for a production rate of 300 pounds of  $UO_3$ /hr/ft<sup>2</sup> of bed cross section. It is felt that direct scale-up is feasible.  $UO_3$  chemical purity was excellent and its physical properties could be controlled by variation of operating conditions. (J.R.D.)

**12636**

DECOMPOSITION OF URANYL FLUORIDE BETWEEN 700° AND 950°C. L. M. Ferris and F. G. Baird (Oak Ridge National Lab., Tenn.). *J. Electrochem. Soc.* **107**, 305-8 (1960) Apr.

The thermal decomposition of uranyl fluoride was studied by a thermogravimetric technique between 700 and 950°C. At temperatures below 900°C, the main decomposition reaction is  $3 UO_2F_2 \rightarrow 2/3 U_3O_8 + UF_6 + 1/3 O_2$ . In an atmosphere of dry helium, the rate of decomposition was first order with respect to uranyl fluoride. The rate constants, determined with a constant helium flow rate of 270 cc (STP)/min, were  $k = 3.72 \times 10^{11} \exp (-71,800/RT)$ . Sublimation of uranyl fluoride, as a parallel, first order process, occurred at temperatures above 825°C. (auth)

**12637**

RECOVERY OF URANIUM FROM SULPHATE LEACH SOLUTIONS BY ANION EXCHANGE. ADSORPTION AND ELUTION IN THE PRESENCE OF PHOSPHATE. M. V. Nayak, T. K. S. Murthy, and D. V. Bhatnagar (Atomic Energy Establishment, Trombay, India). *J. Sci. Ind. Research (India)* **19B**, 20-24(1960) Jan. (In English)

Adsorption of uranium from sulfate solutions containing phosphate on a strong base anion exchanger, Amberlite IRA-400, was studied. The results were compared with those obtained using phosphate-free solutions and significant differences were observed in the breakthrough as well as saturation capacity of the bed. Phosphate in low concentrations was found to increase the adsorption capacity. It was found that the pH of the feed solution within the limits of 1 to 2 has no significant effect on adsorption capacity of the exchanger in the case of phosphate-containing solutions. Elution of uranium from the columns

was studied using one molar chloride and nitrate solutions and it was found that when adsorption is carried out from a phosphate-containing solution, the elution with solutions of low acidity was not quite as efficient as in the case of phosphate-free solutions. For effective elution in the latter case, the acid concentration in the eluant has to be increased to about 0.5N. (auth)

**12638**

URANIUM PRODUCTION AT LE BOUCHET. H. Hueet (Commissariat à l'Énergie Atomique, Paris). *Nuclear Power* **5**, No. 48, 130-31(1960) Apr.

The process used in the production of uranium at Le Bouchet is presented with diagrams showing the reduction of the trioxide to dioxide, the fluorination reactor, and making uranium ingots by reducing  $UF_4$  with calcium. The vertical reduction and fluorination reactors use the "moving bed" technique. The 80-kg ingots produced represent a 99% yield. Very satisfactory trials were carried out using magnesium reduction, giving a mean yield of 95%, with a process similar to that used in the USA and Canada. (B.O.G.)

## Separation Processes

**12639** AECU-4716

Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

PURIFICATION OF THOREX PROCESS SOLVENT. Final Report [for] December 1, 1958 to November 1, 1959. Fred Sicilio, T. H. Goodgame, and Bert Wilkins, Jr. Jan. 31, 1960. 49p. Project No. A-428. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract No. 1374. OTS.

The feasibility of purifying irradiation-degraded Thorex solvent by distillation was proved by these studies. It appears that direct distillation of the TBP-Amsco mixture is beset by too many difficulties to prove technically feasible; however, flash distillation of the mixture into the separate TBP and Amsco components allows the fractional distillation of each component to be performed in a trouble-free manner. The fractional distillation of the TBP-Amsco components, after flash distillation, does not differ substantially from the distillation of unwashed TBP-Amsco components. (W.L.H.)

**12640** AERE-R-3158

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE USE OF URANIUM IV AS A REAGENT IN THE AQUEOUS PROCESSING OF IRRADIATED URANIUM. E. N. Jenkins and R. J. W. Streeton. Dec. 1959. 22p.

The stability, solvent extraction, and reducing power of uranous solutions were investigated in the presence of 3M nitric acid. Important differences in the chemistry of uranium IV compared with ferrous sulfamate include a partial re-oxidation of plutonium III in the presence of dissolved air and excess uranium IV, and the acceleration of the reduction of plutonium IV or VI at low acidity and by catalysts including the sulfate ion. The uranous, like the ferrous ion, must be stabilized against nitrite, e.g., with sulfamic acid or with hydrazine. Uranous sulfamate is a satisfactory alternative to ferrous sulfamate in the uranium purification cycle of a TBP process. It is only suitable for the primary separation of the plutonium, because of high residual levels of uranium, if these can be removed in the subsequent purification of the plutonium, e.g., by anion exchange. (auth)



**12641** CCCO-229

Catalytic Construction Co., Philadelphia.

FMPC SOLVENT TREATMENT AREA—PROCESS DESIGN. Carl Pfeiffer and John B. Maerker. July 6, 1951. Decl. Mar. 7, 1960. 26p. OTS.

The TBP treatment process at the Feed Materials Production Center is described. Drawings, flowsheets, and specifications are included. (W.L.H.)

**12642** CF-60-2-72

Oak Ridge National Lab., Tenn.

EUROCHEMIC ASSISTANCE PROGRAM. Progress Report for October through December 1959. E. L. Nicholson and E. M. Shank. Mar. 31, 1960. 11p. OTS.

The status of the Eurochemic Organization and the preliminary plant design are summarized. Complete ratification of the charter still requires approval by Italy and Sweden. The Board of Directors, with E. Svenke of Sweden as chairman, has been elected and E. Pohland of Germany has been appointed General Manager of the company. Project III, reported last quarter, was not accepted and Project IV was developed within the total monetary framework available ( $\$21.77 \times 10^6$ ); this proposal is expected to be accepted. The Project IV capacity is 350 kg of natural uranium per day or 250 kg of up to 5% enriched uranium per day. Head-end processes being considered are Sulfex for stainless steel-clad fuels, Zirflex for Zircaloy-clad fuels, dilute sulfuric acid for magnesium-clad fuels, and sodium hydroxide for aluminum-clad fuels. The solvent extraction system will consist of a co-decontamination cycle and a second uranium cycle. The second plutonium cycle and anion exchange tail-end step has been eliminated, with an amine extraction cycle being considered as a replacement. Negotiations on the engineering contract are underway with St. Gobain of France. A total of nine people associated with Eurochemic visited four USAEC sites during a three-week tour. Process chemistry and engineering were discussed, along with associated fields of health physics, criticality, analytical, and building design. (auth)

**12643** KR-3

Norway. Institutt for Atomenergi, Kjeller.

SEPARATION OF NITROSYL RUTHENIUM NITRATO COMPLEXES OVER CATION- AND ANION-EXCHANGE RESINS. W. Kraak. Dec. 1959. 17p.

The separation of an equilibrium mixture of nitrosyl ruthenium nitrates over a cation exchange resin into four compounds or mixtures of compounds is described. Comparison is made with paper chromatographical separation. Also the separation over an anion exchange resin is described. (auth)

**12644** KR-4

Norway. Institutt for Atomenergi, Kjeller.

METHOD TO DECREASE THE EXTRACTABILITY OF FISSION PRODUCT RUTHENIUM. W. Kraak. Dec. 1959. 15p.

Experiments are described in which a lower coefficient for ruthenium extraction by tributyl phosphate is obtained after treating fission product ruthenium solutions with nitrogenous gases. (J.R.D.)

**12645** ORNL-2854

Oak Ridge National Lab., Tenn.

CHEMICAL FEASIBILITY OF HOMOGENEOUS NEUTRON POISONS FOR CRITICALITY CONTROLS IN CONSOLIDATED EDISON FUEL PROCESSING SOLUTIONS. J. G. Moore and R. H. Rainey. Apr. 8, 1960. 22p. Contract W-7405-eng-26. OTS.

Laboratory experiments demonstrated the apparent chemical feasibility of incorporating boron, cadmium, or rare earth salts as nuclear poisons for criticality control during the processing of Consolidated Edison reactor fuel. At room temperature up to 18 g of boric acid dissolved per liter of clad or core dissolver solution, i.e., 0.3 M in de-cladding solution (6 M  $\text{H}_2\text{SO}_4$ ) and 0.3 M in Thorex dissolvent (13 M  $\text{HNO}_3$ —0.04 M F—0.1 M  $\text{Al}(\text{NO}_3)_3$ ). Boric acid had no apparent effect on the dissolution of the stainless steel jacket or  $\text{ThO}_2$ - $\text{UO}_2$  core. At room temperature cadmium solubility in 6 M  $\text{H}_2\text{SO}_4$  was 0.3 M and in Thorex dissolvent was >1 M. Gadolinium-samarium mixtures dissolved at concentrations up to 5 g/liter without difficulty. None of these neutron poisons were volatilized to a significant extent (i.e., <6%) during evaporation for feed adjustment. Single solvent extraction cycles were made in which the concentrations of boron, rare earths, and cadmium in the uranium were reduced to 2.5, <4, and <17 ppm, respectively. (auth)

**12646** TID-5720

Massachusetts Inst. of Tech., Cambridge.

EQUILIBRIUM EXTRACTION CHARACTERISTICS OF ALKYL AMINES AND NUCLEAR METALS IN NITRATE SYSTEMS. Quarterly Progress Report No. 6 for the Period October 1—December 31, 1959. Quarterly Report VI. Edward A. Mason and Victor C. Vaughan. Feb. 26, 1960. 29p. For [Oak Ridge National Lab.]. Contract W-7405-Eng-26, Subcontract No. 1327. OTS.

Progress was made on the extraction of nitric acid by DTDA and Primene JMT; the extraction of zirconium by TLA and Primene JMT in toluene, in Amsco, and in Amsco with diluent modifiers at 25°C; and the extraction of nitrosyl ruthenium nitrates by TLA and DTDA in toluene. Extractions of nitric acid by Primene JMT and di(tridecyl) amines in toluene do not show the linear dependence on aqueous acid concentration found with triauryl amine (1), even though the amine nitrate is formed and excess acid is dissolved. This "excess acid" in Primene JMT follows the 2.3 power and in DTDA the 1.8 power of the aqueous acid strength and is linearly dependent on amine concentration and percent PDA diluent modifier for a given aqueous acidity. Although the preponderance of K values for JMT were below those for TLA, from consideration of values of  $\sigma$ , it is seen that the K's for each of the two amines are equal within statistical limits. Ruthenium extractions carried out at 25°C for various shaking times indicate that although the rate of change of concentration is slow at 95 hours, equilibrium is not attained in this time. The value of  $E_A^{\text{Ru}}$  at 24 hours is >80% of the value of 95 hours, and consequently appears to be an adequate shaking time to differentiate among the amines. Extractions made with TLA in toluene showed increasing extraction of Ru with decreasing acidity. Over the range 8N  $\text{HNO}_3$  to 2N  $\text{HNO}_3$  + 4N  $\text{NaNO}_3$  the distribution ratio varied from ~0.015 to 0.13. DTDA showed extractions near the analytical limit of detectability and consequently  $E_A^{\text{Ru}}$  values are lower,  $E_A^{\text{Ru}} \approx 0.023$ . (auth)

**12647** TID-5724

Battelle Memorial Inst., Columbus, Ohio.

EXAMINATION OF TITANIUM STEAM COIL FROM A PUREX EVAPORATOR. F. W. Fink. Mar. 31, 1960. 8p. OTS.

Failure occurred in a section of titanium steam coil in Purex acid-recovery evaporator. Data from an investigation indicated the failure to be mechanical. The proposed cause is that a vertical member of the assembly rubbed against the coil. (C.J.G.)

**12648**

PHOTOLYTIC SEPARATION OF URANIUM FROM BERYLLIUM AND ZIRCONIUM. K. Singh, Balaram Sahoo, and D. Patnaik (Ravenshaw Coll., Cuttack, India). *J. Sci. Ind. Research (India)* **19B**, 31-2(1960) Jan. (In English)

The photochemical separation of uranium from beryllium and zirconium in the presence of alcohol and sunlight is reported. Experiments conducted at different pH values revealed that beryllium and zirconium precipitated with uranium above pH-3 and below pH-2 the yield of uranium became less, though the purity was unaffected. For separations from beryllium at pH 2.0 to 2.5 the uranium recovery was 91.4 to 97.4%, and for zirconium at pH 2.0 to 3.0 the recovery was 95.5 to 96.9% of the initial sample. Experiments conducted with formic acid in place of alcohol resulted in uranium recovery in a pure state. (B.O.G.)

**12649**

PURIFICATION OF METALS BY GAS CHROMATOGRAPHY. F. E. DeBoer (Argonne National Lab., Lemont, Ill.). *Nature* **185**, 915(1960) Mar. 26.

A method is presented which suggests that metals can be efficiently separated by gas chromatography. The feasibility of this process was tested using a cadmium-8.4% zinc alloy. The advantages of this alloy are: (1) both elements have significant vapor pressures; (2) chemical similarity; (3) common metals; and (4) pose no handling problems. The process yielded a cadmium content of more than 200 times the zinc content. By slightly altering the process, a zinc deposit equal to or greater than the cadmium deposit was obtained. (B.O.G.)

**12650**

THE MARCOULE PLUTONIUM EXTRACTION PLANT. THE ONLY INDUSTRIAL FACILITY OF ITS KIND IN CONTINENTAL EUROPE. *Nuclear Power* **5**, No. 48, 137-9(1960) Apr.

A description is presented of the process through which a spent fuel element from the Marcoule power reactors G1, G2, and G3 goes in the extraction of plutonium. The processing plant is divided into three carefully ventilated zones: active, semi-active, and inactive. The extraction process is conducted in the active area; measuring transmitter and sampling apparatus found in the semi-active zone; and the process is controlled by personnel in the inactive area. Each area is separated from the other by a protective concrete wall with the semi-active area between the other two. No one is allowed in the active area until decontamination is completed and access to the semi-active area for short periods is allowed to specialists for sampling, maintenance, and other control operations. The operations are viewed by television or special windows. (B.O.G.)

**12651**

CYCLOTRON TARGETS USING ENRICHED STABLE ISOTOPES. P. S. Baker, F. R. Duncan, and L. O. Love (Oak Ridge National Lab., Tenn.). *Nuclear Sci. and Eng.* **7**, 325-6(1960) Apr.

The use of enriched stable isotopes in the cyclotron production of radioisotopes is not only possible, but can also be economically advantageous. The feasibility is related directly to the efficiency of recovery of the unconverted target material. Some of the techniques and problems which are encountered in the preparation of and recovery of  $\text{Te}^{125}$ ,  $\text{Te}^{130}$ , and  $\text{Cr}^{54}$  are discussed. (auth)

**12652**

IMPROVEMENTS RELATING TO ION-EXCHANGE PROCESSES AND APPARATUS. Thomas Victor Arden and

Robert Rampton Porter (to Permutit Co., Ltd.). British Patent 831,206. Mar. 23, 1960.

A continuous ion-exchange process is described for separating U from low-grade ores. The ore is dissolved in acid in the presence of oxidizing agents, clarified by settling, decanted, or filtered and passed through ion-exchange beds. The U adsorbed on the beds is eluted by  $\text{NH}_4\text{NO}_3$  solution, and the U is precipitated as oxide. A system of exchanger beds is described which provides for alternate elution and absorption by each bed so that little U loss occurs and a greater efficiency of recovery is achieved. (T.R.H.)

## ENGINEERING AND EQUIPMENT

### General and Miscellaneous

**12653** HE-150-158

California. Univ., Berkeley. Inst. of Engineering Research

DESIGN CONSIDERATIONS AND REGION OF OPERATION OF THE JET DIFFUSION EQUIPMENT. J. W. Eerkens. July 8, 1957. 20p. Project 35. Contract AT(11-1)-34. OTS.

An account is given of the design parameters which dictate the dimensions of the jet diffusion equipment. Based on this investigation, the length of the test chamber was chosen to be 130 cm. In connection with this study, charts were constructed which show the expected regions of jet flow which the equipment is capable of producing. (auth)

**12654** HW-63052

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

BEHAVIOR OF A BOILING METAL THERMOSIPHON LOOP. G. Jansen, Jr. Dec. 1, 1959. 34p. Contract AT(45-1)-1350. OTS.

The boiling characteristics of the system lead-bismuth eutectic-mercury were studied in a one-inch ID quartz tube containing a two-foot column of metal. Uniform internal heat generation was simulated by induction heating. Temperatures of operation ranged from 360 to 550°C as the percentage mercury was varied from 100 to 5%. Operation with a simple boiling tube resulted in violent surging and slugging of the vapor bubbles. Operation with liquid recirculation by thermosiphon action resulted in stable operation with steady boiling in only the top portion of the column. This type of operation was promoted by the high liquid density, which provided both a high driving force for liquid recirculation and a high static head boiling point rise with liquid depth. A maximum power input to mercury vaporization of 0.3 KW per foot of heated tube length was reached. Although this power input is an order of magnitude below the level desired in a reactor, calculations show that lowering of the resistance to flow in the thermosiphon loop may permit operation at the desired power level. Preliminary results showed that the freezing points for the system were above room temperature with attendant freezing problems. (auth)

**12655** HW-64269

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

CRITICAL PRESSURE RATIO FOR A NOZZLE WITH TWO-PHASE FOG FLOW. W. J. Love. Mar. 8, 1960. 13p. OTS.

The critical-pressure ratio for a nozzle with two-phase fog flow as a function of either upstream or downstream



conditions is presented. The critical-pressure ratio is shown as a function of inlet to throat area ratio and inlet or throat conditions. Critical flow charts are included. (W.L.H.)

#### 12656 JPL-PR-30-14

California Inst. of Tech., Pasadena. Jet Propulsion Lab. EXTERNALLY PRESSURIZED JOURNAL GAS BEARINGS. John H. Laub. Nov. 1, 1959. 25p. Contract NASw-6.

Externally pressurized gas-lubricated bearings with multiple orifice feed are investigated. An analytical treatment is developed for a semicylindrical bearing with 9 orifices and for a cylindrical journal bearing with 192 radial and 24 axial orifices. Experiments are described on models of the two bearing configurations with specially designed fixtures which incorporate pneumatic loading and means for determining pressure profiles, gas flow and gap height. The correlation between theory and experiment is satisfactory. (auth)

#### 12657 TID-5697

General Electric Co. Missile and Space Vehicle Dept., Philadelphia.

#### HIGH ENERGY STORAGE CERAMIC CAPACITOR.

Quarterly Report No. 11 [for] July 1, 1959–September 30, 1959. V. A. Russell. 57p. Contract AT(30-1)-1963. OTS.

Major emphasis was placed on a grain size study in an attempt to get some correlation between grain size and dielectric strength. Many five-inch capacitors were fabricated and tested during the quarter. The breakdown mechanism in barium-strontium titanate ceramics is discussed. Some experiments showing the breakdown field and current as functions of temperature were performed. Some five-inch disks were isostatically pressed and machined while green. (For preceding period see TID-5696). (W.D.M.)

#### 12658 TID-5699

Southwest Research Inst., San Antonio.

#### CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE

VESSELS. Progress Report No. 17 Covering the Period from February 15 to March 16, 1960. M. M. Lemcoe. Mar. 15, 1960. 22p. Project No. 773-2. Contract AT(30-1)-2140. OTS.

The vessels under plastic fatigue investigation have a 36-inch I.D. and 2-inch wall thickness and contain nozzles of several designs and sizes. The program includes essentially identical pairs of full size vessels fabricated from A-201, A-302, and T-1 steels. Stress analysis and fatigue cycling on the No. 1, A-201 vessel were completed, and fatigue cycling of the second vessel at 2650 psi is in progress. Stress concentration factors determined in the static stress analysis, initial cycling, and results of plastic fatigue tests will be correlated with results of related studies at other labs. (W.D.M.)

#### 12659 UCRL-5678

California. Univ., Livermore. Lawrence Radiation Lab. and San Francisco Operations Office, AEC.

PROCEEDINGS OF THE SECOND PLOWSHARE SYMPOSIUM. PART IV. INDUSTRIAL USES OF NUCLEAR EXPLOSIVES IN THE FIELDS OF WATER RESOURCES, MINING, CHEMICAL PRODUCTION, PETROLEUM RECOVERY. Plowshare Series: Report No. 2. May 15, 1959. 102p. Contract W-7405-eng-48. OTS.

Industrial uses of nuclear explosives in the fields of water resources, mining, chemical production, and petroleum recovery are discussed. The economics of using nuclear explosives are compared with conventional methods. Separate abstracts have been prepared on eight papers presented at this symposium. (C.H.)

#### 12660 UCRL-5678(p.4-7)

California. Univ., Los Angeles. Inst. of Geophysics. SALT WATER DISTILLATION. George C. Kennedy. 4p.

The utilization of the heat produced in an underground nuclear explosion for the distillation of sea water to produce fresh water is discussed. It is stated that the process appears to be possible and economical. The fundamental principles of distillation are reviewed and a phase equilibrium diagram of the sodium chloride–water system is presented. (C.H.)

#### 12661 UCRL-5678(p.8-12)

California. Univ., Livermore. Lawrence Radiation Lab. HEAT REQUIREMENTS FOR THE HIGH PRESSURE DISTILLATION OF SEA WATER. Raymond L. Olson. 5p.

In a proposed method for the high pressure distillation of sea water the distillation would take place in a deep underground cavity formed by the explosion of a nuclear device. The high pressure in the cavity would be maintained by the hydrostatic heads of sea water and distilled water in the piping above the cavity. A depth of over 5,000 feet has been suggested. The heat of distillation would come from the heat of the nuclear explosion stored in the material surrounding the cavity; the separated salt would be left in the cavity. By transferring heat from the outgoing distilled water to the incoming sea water, the amount of heat necessary for the distillation can be minimized. The thermal efficiency of the process and heat requirements for the distillation are discussed. Preliminary cost estimates for the process are included. (C.H.)

#### 12662 UCRL-5678(p.13-20)

California. Univ., Livermore. Lawrence Radiation Lab. THE IMPROVEMENT OF UNDERGROUND WATER SUPPLIES. Frank L. Adelman and Harlan Zodtner. 8p.

The mechanism of subsurface water flow is discussed. In a region where more water is being removed from an underground supply than is being returned by either natural processes or human efforts, the water problem manifests itself by a lowering of the water table or the ground overlaying the water supply may subside. Applications of nuclear explosives for the improvement of subsurface reservoirs and the improvement of hydrologic environments are discussed. (C.H.)

#### 12663 UCRL-5678(p.42-5)

California. Univ., Livermore. Lawrence Radiation Lab. MINING WITH NUCLEAR EXPLOSIVES. C. R. Adelman, Jr. 4p.

The general operational procedures involved in detonating a nuclear explosive are described. Applications of nuclear explosives in mining are discussed. Theoretical applications in strip, open-pit, and quarry mining methods are considered. (C.H.)

#### 12664 UCRL-5678(p.46-65)

Colorado School of Mines Research Foundation, Inc., Golden.

EXPLOITATION OF LARGE OREBODIES BY CONVENTIONAL VERSUS NUCLEAR MEANS. Fred L. Thomas and Thomas R. Young. 20p.

The economics of exploiting large, low-grade porphyry copper deposits by conventional block caving and either flotation to recover the valuable mineral or surface leaching for the copper recovery are compared with the economics of shattering the orebody by a nuclear device and leaching the broken material in place. Several possible applications are considered for control of rock bursts or breaking of caprock to enable more satisfactory mining by block caving. Cost estimates are included. (C.H.)

**12665 UCRL-5678(p.74-9)**

Dow Chemical Co., Midland, Mich.

**LARGE SCALE CHEMICAL REACTIONS UNDERGROUND.**

John J. Grebe and E. V. Luoma. 6p.

Applications of the energy from hydrogen fusion as a source of high-temperature heat for underground thermochemical reactions are considered. In underground reactions the raw materials will be used in and from the place where nature deposited them, no reaction vessels will be needed, and the heat necessary for the reactions will come from the detonation of a thermonuclear device. Higher temperatures than those previously economically possible will be easily and cheaply obtained. Ultrahigh temperatures combined with pressures will be available during the explosion. Afterwards, temperatures of over 1000°C and pressures of over 100 atmospheres will be readily available in many of the formations. Reactions in limestone, oil shale, salt, and siliceous rock are discussed. (C.H.)

**12666 UCRL-5678(p.80-101)**

Bureau of Mines. Oil Shale Research Branch, Laramie, Wyo.

**IN SITU SHALE OIL PRODUCTION PROBLEMS.** Walter I. R. Murphy. 22p.

Proposed Plowshare experiments in oil shale are described. The experiments consist of a nuclear phase, in which an atomic device would be detonated; and an oil recovery phase, in which a study would be made of methods for producing shale oil by *in situ* combustion of the shale broken in the nuclear phase. Some of the problems involved are discussed. Methods are suggested for operating an *in situ* project in oil shale. (C.H.)

**12667 UCRL-5840**

California. Univ., Livermore. Lawrence Radiation Lab. INDUSTRIAL AND SCIENTIFIC APPLICATIONS OF NUCLEAR EXPLOSIONS. Gerald W. Johnson. Jan. 19, 1960. 34p. Contract W-7405-eng-48. OTS.

Information is given for a series of underground and surface nuclear explosions ranging from 0.055 to 19 kilotons in size. A model of four stages is developed and applied to the case of the Rainier explosion: (1) Nuclear Reaction, microsecond range. (2) Hydrodynamic Phase, millisecond range. (3) Quasi-Static Phase, second-minute range. (4) Longer-Term Phase, minute-year range. Data are given for the growth rate of the Rainier cavity up to 75 msec, partition of energy in the second stage, and distribution of temperature 5 months after the Rainier explosion. The following generalizations were made for tuff soil: Radioactivity can be contained completely underground at depths of  $D = 400 W^{1/3}$  or greater, where  $W$  is the energy release in kilotons; the cavity initially formed has a radius of  $R = 50 W^{1/3}$ ; and 65 to 80% of the fission-product activity is in dilute (0.1 ppm) glass solution. The purpose and scheme of the three current AEC projects, Gnome, Project Oil Sand, and Project Chariot, are given. Also, some experiments to be done with nuclear explosions are suggested for space research, production of transplutonic isotopes, neutron resonance, other cross sections, earth's structure, and seismology. (D.L.C.)

**12668 WAL-TR-834.12/1**

Watertown Arsenal Lab., Mass.

**RESPONSE OF BEAMS TO DYNAMIC PRESSURE LOADING WITH MEMBRANE EFFECTS INCLUDED.** E. W. Ross, Jr. Mar. 1960. 25p. DA Project 5B3-32-005. OTS.

The plastic-rigid model of beam behavior is used to calculate the response of either simple or clamped beams to

rapidly applied transverse loads which are symmetrically distributed about the midpoint of the beam. The effects of membrane force are included in the analyses. A specific example is worked out to show the effect of including membrane force in the analysis of a beam. (auth)

**12669 IGIS-35(RD/R)**THE PROBLEM OF MEASURING LOSSES ON THREE-PHASE GENERATORS. E. Alm. Translated by G. A. Burras (U.K.A.E.A., Risley) from *Tek. Tidskr.* 87, 203-6(1957). 10p.

The influence of the weight of the turbine wheel on heat losses of three phase generators is discussed relative to dimensions of the main bearing and theory of main bearing losses. Calculations are presented for main-bearing losses at maximal load and for generator rotor alone. Expressions are presented for calculating losses in the turbine guide bearing, in the seal box, and turbine-wheel ventilation losses. Example calculations using the derived expressions are given. (C.J.G.)

**12670**TRANSIENT PISTON RING WEAR IN AUTOMOTIVE ENGINES USING Fe<sup>59</sup>. James J. Gumbleton, Farno L. Green, and William J. Mayer (General Motors Corp., Warren, Mich.). *Nuclear Sci. and Eng.* 7, 313-19(1960) Apr.

A single cylinder engine with a radioactive iron piston ring was used to observe transient wear during break-in, cold start-up, and changes in speed. Small changes in engine speed and load under some conditions produce more wear during a given time interval than steady-state operation at high speeds and loads. Measuring transient wear is more difficult than measuring steady-state wear partially because of insufficient counting rates. Errors in measurements due to counting statistics were analyzed. High counting rates are necessary for reproducible measurements of fast transient wear such as that which occurs with an automatic transmission during acceleration. When premium lubricating oils are used, the piston rings should have specific activities of 3.0 to 30.0 mc/g of Fe<sup>59</sup>. (auth)

**12671**ELECTROLUMINESCENCE WITH A PERPETUAL RADIOACTIVE LAMP. R. Nampon. *Rev. gén. mécan.* 43, No. 118, 59-60(1959) Jan. (In French)

When an electron beam strikes a fluorescent surface, the surface emits light. If a radioactive substance, which emits  $\beta$  rays, and a fluorescent screen are enclosed within the same bulb, a lamp is obtained which does not require any outside energy and cannot be extinguished. The radioactive substance should be (1) gaseous so that in case of breakage the activity will disappear rapidly, (2) the best source of  $\beta$  radiation obtainable, and (3) it should have a sufficiently long bulb life. These conditions are best met by using H<sup>3</sup> and Kr<sup>85</sup>, the latter having the additional advantage of being inert. Kr<sup>85</sup> lamps, which are manufactured now on an industrial scale, can be seen at a distance of 200 m in complete darkness. They can be used as signal lights in salvage boats, for illuminating exit signs, and in cases where visibility should be maintained even after the interruption of all other sources of power supply. (OID)

**12672**DEVICE FOR ULTRA-HIGH-PRESSURE HIGH-TEMPERATURE RESEARCH. W. B. Wilson (Battelle Memorial Inst., Columbus, Ohio). *Rev. Sci. Instr.* 31, 331-3(1960) Mar.

A new device has been developed for materials research at high pressures and high temperatures. The unit may be described as an extension of the Bridgman "anvil" modi-



fied to permit internal heating. The principle of "massive support" is retained with pressure being achieved through the elasticity of multiple binding rings, rather than through the "compressible" gasket effect. The unit has been calibrated to pressures beyond 100,000 atm with temperature to 2000°C. The operational characteristics of the device and problems associated with high-pressure high-temperature research are discussed. (auth)

#### 12673

HIGH-TEMPERATURE MOLTEN-SALT LUBRICATED HYDRODYNAMIC JOURNAL BEARINGS. P. G. Smith. Preprint No. 60AM 5A-3. Presented at the 15th ASLE Annual Meeting April, 1960 in Cincinnati, Ohio. Chicago, American Society of Lubrication Engineers, 1960. 28p. \$0.75.

Hydrodynamic lubrication of journal-type bearings was tested over the temperature range of 1200 to 1500°F with molten salt No. 130 (62 LiF-37 BeF<sub>2</sub>-1UF<sub>4</sub>, mole %). A number of tests was performed to investigate hydrodynamic lubrication at steady-state operating conditions, the ability to stop and restart rotation of the journal, performance over a range of Sommerfeld Number from 0.009 to 2.0, thermal stability of the bearing material, and bearing configurations for sustaining unidirectional and bidirectional radial loading. These tests comprised 3900 hr of operation at high temperatures. One test covered a period of 1000 hr at steady-state conditions and another covered a period of 272 hr, in which 260 start-stop operations were performed. All the test bearings and journals were constructed of a nickel-molybdenum alloy. A molten-salt bearing was attached to a vertical centrifugal pump, and a preliminary test was performed. (auth)

#### 12674

THE LUBRICATION REQUIREMENT OF NUCLEAR POWERED SURFACE VESSELS—DESIGN CONSIDERATIONS. E. H. Okrent (Esso Research & Engineering Co., Linden, N. J.). Preprint No. 60AM 2B-3. Presented at the 15th ASLE Annual Meeting April, 1960 in Cincinnati, Ohio. Chicago, American Society of Lubrication Engineers, 1960. 33p. \$0.75.

The effect of nuclear surface vessel design on the functional requirements of lubricants is studied. The critical design features of potential nuclear surface propulsion systems are reviewed to determine the physical requirements imposed on the lubricant by the total environment, radiation being only one of the many factors to be considered. This review indicates that the lubrication problems of nuclear propelled ships are similar to those of their conventional fossil-fueled counterparts. Radiation stress, the main new environmental feature, is a consideration only in those components which are associated with the nuclear heat source (control rods, etc.), and then it is generally not a controlling consideration. The lubricants for the propulsion gear and its auxiliary systems present no new lubrication problems. However, leakage and primary coolant contamination requirements often take precedence in the selection of the lubricant or lubrication system. (auth)

## Heat Transfer and Fluid Flow

#### 12675 CEA-1303

France. Commissariat à l'Énergie Atomique, Paris. CONVECTION FORCÉE DE LA CHALEUR DANS LES ESPACES ANNULAIRES. (Forced Heat Convection in Annular Spaces). Jacques Pelcé. Feb. 6, 1960. 87p.

Thesis submitted to Univ. of Poitiers.

An experimental study was made of forced heat convection in annular spaces through which flow of air is passing when a uniform heat flux is dissipated across the inner wall. The observations took place chiefly in the region where thermal equilibrium was not yet established. Among other things it became apparent that, both in the region where thermal equilibrium conditions are on the way to establishment and where they are already established, the following relationship held good: the longitudinal temperature gradient, either on the wall or in the fluid stream, is proportional to the heat flux dissipated  $q$ , and inversely proportional to the average flow rate  $V$ :  $(dT/dx) = B (q/V)$ . From this result the next step is to express the variations of the local convection coefficient  $\alpha$  (or of the Margoullis number  $M$ ) in a relationship of the form:  $(1/M) = \psi(V) + F(x)$ . If this relationship is compared with the classical empirical relationship  $\alpha = KV^n$  (where  $n$  is close to 0.8), the relationship:  $(1/M) = \xi V^{1-n} + F(x)$  is obtained ( $\xi$  is a constant for a given annular space); from this it was possible to coordinate the whole set of experimental results. (auth)

#### 12676 ORNL-2911

Oak Ridge National Lab., Tenn.

HEAT TRANSFER, BURNOUT, AND PRESSURE DROP FOR WATER IN SWIRL FLOW THROUGH TUBES WITH INTERNAL TWISTED TAPES. W. R. Gambill, R. D. Bundy, and R. W. Wansbrough. Apr. 11, 1960. 108p. Contract W-7405-eng-26. OTS.

Experimental determinations of heat-transfer coefficients, burnout heat fluxes, and friction factors were made for swirl flow of low- and moderate-pressure water through electrically heated aluminum, nickel, and copper tubes containing full-length Inconel twisted tapes. (auth)

#### 12677 WAPD-TM-210

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

A DIMENSIONAL ANALYSIS OF THE DEPARTURE FROM NUCLEATE BOILING HEAT FLUX IN FORCED CONVECTION. P. Griffith. Dec. 1959. 26p. Contract AT-11-1-GEN-14. OTS.

As part of the current effort to produce new and improved forced convection departure from nucleate boiling (DNB) heat flux correlations that would be applicable over a wide range of water conditions, a dimensional analysis of DNB was performed. This analysis was performed by non-dimensionalizing the momentum, energy and continuity equations and applying selected boundary conditions. From this treatment, a number of dimensionless groups were formulated, and the DNB heat flux was expressed in terms of

$$\frac{\phi_{DNB}}{h_{fg} \rho_g V_1} = f \left( \frac{L}{S}, \frac{V_1 S \rho_f}{\mu_f}, \frac{V_1 S \rho_g}{\mu_g}, \frac{C \mu_f}{k}, \frac{\sigma}{\rho_f V_1^2 S}, \frac{k (T_s - T_1) \rho_f}{h_{fg} \rho_g S V_1 \rho_g \beta} \right)$$

This relationship is applicable to various fluids over a wide range of conditions. By means of a heat balance, the continuity equation and the equation of state,  $\phi_{DNB}$  can then be expressed in terms of local conditions plus the  $L/S$  term. (auth)

#### 12678 TG-230-T68

RADIANT HEAT EXCHANGE IN COOLED GAS-TURBINE COMBUSTION CHAMBERS. S. N. Shorin. Translated by R. P. Illwitzer (Johns Hopkins Univ.) from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, No. 10, 99-111(1954). 17p.

The role of radiant energy in power conversion in a

burning stream is analyzed theoretically. An energy equation is derived similar to that obtained in the thermal theory of flame propagation, but containing a radiant energy term. The concept of radiant temperature for the radiation field characteristics, which can be defined as the equivalent amount of radiant energy per unit volume under conditions of thermodynamic equilibrium, is introduced. This concept is used to derive a formula for determining heat transfer by diffuse radiation. (auth)

**12679**

WELL-INFORMED HEAT ENGINE: EFFICIENCY AND MAXIMUM POWER. C. Finfgeld and S. Machlup (Western Reserve Univ., Cleveland). Am. J. Phys. **28**, 324-6(1960) Apr.

Further analysis is presented of a thought experiment due to Raymond, which permits an apparent violation of the second law of thermodynamics (the conversion of heat into work by a cyclic process), utilizing spontaneous fluctuations, and supplying the negentropy in the form of information obtained by counting. The thermodynamic efficiency of the heat engine itself is unity; considering the engine and counting demon together preserves the sanctity of the second law. An expression is derived for the power delivered by the engine, and the maximum value of this expression is studied as a function of the various parameters. (auth)

**12680**

THE EFFECT OF THERMAL CYCLING OF INTEGRAL-FINNED DUPLEX TUBES. Edwin H. Young and Marvin L. Katz (Univ. of Michigan, Ann Arbor). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 5-11(1959).

The effect of thermal cycling to 350 and 600°F on the heat transfer performance of duplex integral-finned tubes is reported. The primary heat transfer variable affected by thermal cycling was the bond resistance of the tubes. The phenomenon of bond resistance is discussed, and an apparatus for the measurement of bond resistance is described. Curves indicating the variation in bond resistance as a function of the number of thermal cycles for four copper-liner tubes cycled to 350°F, ten admiralty-liner tubes cycled to 350°F, and four admiralty-liner tubes cycled to 600°F are presented and discussed. The effect of bond resistance on the over-all coefficient of an air cooler is indicated. (auth)

**12681**

DESCRIPTION AND EXPERIMENTAL RESULTS OF TWO REGENERATIVE HEAT EXCHANGERS. E. K. Dabora, M. P. Moyle, R. Phillips, J. A. Nicholls, and P. L. Jackson (Univ. of Michigan, Ann Arbor). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 21-8(1959).

This paper was previously abstracted and appears in NSA, Vol. 13, as abstract No. 1648.

**12682**

LOCAL SHELL-SIDE HEAT TRANSFER COEFFICIENTS IN THE VICINITY OF SEGMENTAL BAFFLES IN TUBULAR HEAT EXCHANGERS. M. S. Gurushankariah and J. G. Knudsen (Oregon State Coll., Corvallis). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 29-36(1959).

Local heat transfer coefficients were studied in detail in the central baffle space between two segmental baffles in a tubular heat exchanger. Two baffle spacings and three flow rates were investigated. Average over-all Nusselt numbers determined from the measured local coefficients compare favorably with average Nusselt numbers measured by other workers. The data are presented in picture form, which permitted a schematic diagram of the flow pattern in the baffle space to be drawn. The results indicate the

presence of three flow zones between two baffles. The longitudinal-flow zone occurs in the baffle windows; the cross- and eddy-flow zones occur on the downstream and upstream sides of the baffle space, respectively. Heat transfer rates were in general higher in the eddy-flow zone. The heat transfer rate varies along individual tubes from a maximum at the baffle to a minimum midway in the baffle. The minimum value is one-fourth to one-half the value at the baffle. (auth)

**12683**

HEAT TRANSFER AND PRESSURE DROP OF AIR IN FORCED CONVECTION ACROSS TRIANGULAR PITCH BANKS OF FINNED TUBES. D. J. Ward and E. H. Young (Univ. of Michigan, Ann Arbor). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 37-44(1959).

This paper was previously abstracted and appears in NSA, Vol. 13, as abstract No. 1649.

**12684**

HEAT TRANSFER AND FLUID FRICTION DURING FLOW ACROSS BANKS OF TUBES. VII. BYPASSING BETWEEN TUBE BUNDLE AND SHELL. O. P. Bergelin (Univ. of Decca, East Pakistan); K. J. Bell (Case Inst. of Tech., Cleveland) and M. D. Leighton (Univ. of Delaware, Newark). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 45-58 (1959).

Results were reported on the pressure drop and rate of heat transfer during flow across tube banks and for flow on the shell side of a cylindrical, baffled heat exchanger with and without appreciable internal leakage across the baffle. A method was proposed for predicting the performance on the shell side of baffled exchangers from the cross-flow data from rectangular tube banks and baffle-leakage coefficients. Information on the flow between the outer row of tubes and the shell wall in rectangular tube banks is presented. The results presented include isothermal, heating, and cooling runs in both the laminar and turbulent regimes for two tube-bank geometries with various bank-to-shell clearances. The effect of sealing strips to block the bypass stream is shown. Methods of generalizing the results for commercial exchanger design are considered. (auth)

**12685**

FORCED-CONVECTION, LOCAL-BOILING HEAT TRANSFER IN NARROW ANNULI. Louis Bernath and William Begell (Columbia Univ., New York). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 59-65(1959).

Heat transfer data in the region of fully developed local boiling were collected, analyzed, and correlated. The results of this analysis permit the prediction of the wall superheat for the range of the variables studied. A proposed local boiling film concept is shown to agree with experimental observations. (auth)

**12686**

HEAT TRANSFER RATES TO BOILING FREON 114 IN VERTICAL COPPER TUBES. H. L. Foltz and R. G. Murray (Goodyear Atomic Corp., Portsmouth, Ohio). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 79-86(1959).

This paper was previously abstracted and appears in NSA, Vol. 13, as abstract No. 1650.

**12687**

BUBBLE GROWTH RATES IN HIGHLY SUBCOOLED NUCLEATE BOILING. S. G. Bankoff and R. D. Mikesell (Rose Polytechnic Inst., Terre Haute, Ind.). Chem. Eng. Progr. **55**, Symposium Ser. No. 29, 95-102(1959).

By comparison of the Rayleigh solution for bubble growth and collapse with experimental data, it is found that the pressure of the vapor within bubbles arising in very sub-



cooled nucleate boiling is less by a small, fairly constant amount than the pressure at a great distance. The effect is the same as if the bubble surroundings were imparted an initial impulse while the minute bubble was still entirely within the laminar-wall layer. The kinetic energy imparted by this initial impulse and the restraining pressure difference determine the bubble trajectory. These parameters are computed for Gunther's data. It is then postulated that the heat flux from the portion of the bubble projecting into the turbulently-flowing core depends primarily upon turbulent and convective heat flow rather than laminar heat conduction and hence is relatively constant during the bubble lifetime. The proposed mechanism gives qualitative agreement with the observed trends. It is suggested that latent heat transport may be an important mode of heat transfer in subcooled nucleate boiling. (auth)

#### 12688

ACTIVE SITES FOR NUCLEATE BOILING. H. B. Clark (E. I. du Pont de Nemours and Co., Newport, Del.); P. S. Streng (Eastman Kodak Co., Rochester, N. Y.) and J. W. Westwater (Univ. of Illinois, Urbana). Chem. Eng. Progr. 55, Symposium Ser. No. 29, 103-10(1959).

Photography during and after nucleate boiling was used to identify active bubble-producing sites. Ether and pentane were tested on vertical surfaces of pure zinc and an aluminum alloy at atmospheric pressure. Numerous still photographs at magnifications between 160X and 864X and a few electron micrographs at a magnification of 25,000X were obtained. These plus high-speed motion pictures having a magnification on the negative of 13X show definitely that pits with diameters between 0.0003 and 0.003 in. are very active nucleation sites. Some scratches, a plastic-metal interface, and a mobile speck of unidentified material were active sites. In no case did bubbles form at grain boundaries. No difference in activity could be found for the various crystal faces of zinc, and anisotropic material. (auth)

#### 12689

THE EFFECTS OF SUPERIMPOSED FORCED AND FREE CONVECTION ON HEAT TRANSFER AND PRESSURE DROP IN A HORIZONTAL RECTANGULAR DUCT. M. Altman and F. W. Staub (General Electric Co., Schenectady, N. Y.). Chem. Eng. Progr. 55, Symposium Ser. No. 29, 111-19(1959).

Average and local heat transfer coefficients and flow friction data are reported for a rectangular horizontal duct 2.6- by 1.72-in. cross section and 13.5 ft. long. Variables include a range of Grashof numbers from  $5 \times 10^4$  to  $5 \times 10^6$  and Reynolds numbers from 1,000 to 10,000, all based on equivalent duct diameter. Axial wall temperature distributions, duct position, and inlet shape were varied. Average heat transfer coefficients and duct friction factors were correlated for both linear and nonlinear axial wall temperature distributions using a free-convection correction factor. (auth)

#### 12690

THE EFFECTS OF SUPERIMPOSED FORCED AND FREE CONVECTION ON HEAT TRANSFER IN A VERTICAL RECTANGULAR DUCT. M. Altman and F. W. Staub (General Electric Co., Schenectady, N. Y.). Chem. Eng. Progr. 55, Symposium Ser. No. 29, 121-6(1959).

Average and local experimental heat transfer coefficients are reported for a vertical duct of rectangular cross section where the mean air flow is from the top to the bottom of the duct and where heat is being added to the air at the walls. Results are given for a Reynolds number range of 1,800 to 10,000 based on the equivalent duct diameter for

a duct length to equivalent diameter ratio of 69. The characteristic "dip region" in the transition zone between turbulent and laminar flow conditions is absent for Grashof numbers greater than  $2 \times 10^5$  based on diameter. (auth)

#### 12691

MECHANICALLY AIDED HEAT TRANSFER. D. Q. Kern and H. J. Karakas (D. Q. Kern Associates, Cleveland and Rodney Hunt Machine Co., Orange, Mass.). Chem. Eng. Progr. 55, Symposium Ser. No. 29, 141-8(1959).

Heat transfer devices with moving parts implement phase changes to and from viscous Newtonian and non-Newtonian fluids. By combining certain principles of heat and mass transfer, hydrodynamics, and rheology, equations are developed for the design of these machines and the prediction of their performance. A numerical example illustrates the use of the derived equations. (auth)

#### 12692

CONDENSING HEAT TRANSFER WITHIN HORIZONTAL TUBES. W. W. Akers, H. A. Deans, and O. K. Crosser (Rice Inst., Houston, Tex.). Chem. Eng. Progr. 55, Symposium Ser. No. 29, 171-6(1959).

This paper was previously abstracted and appears in NSA, Vol. 13, as abstract No. 1651.

#### 12693

HEAT TRANSFER. E. R. G. Eckert, James P. Hartnett, T. F. Irvine, Jr., and E. M. Sparrow (Univ. of Minnesota, Minneapolis). Ind. Eng. Chem. 52, 327-39(1960) Apr.

A review of the literature published during 1959 in the field of heat transfer is given. Astronautical developments were responsible for research on the influence of chemical reactions, phase changes, and low-density conditions on heat transfer. The areas of heat transfer reviewed are: conduction, channel flow, boundary layer flow, flow with separated regions, transfer mechanisms, natural convection, convection from rotating surfaces, combined heat and mass transfer, change of phase, radiation, liquid metals, low-density heat transfer, measurement techniques, and heat transfer applications. (B.O.G.)

#### 12694

CONDUCTION HEAT-FLOW TRANSIENTS. Joseph S. Hucks and A. L. Gaines (Combustion Engineering, Inc., Chattanooga). Nucleonics 18, No. 4, 66-7(1960) Apr.

Transient conduction heat flow required in reactor design is given in two areas: thermal-stress analysis and heating- and cooling-rate requirements. Curves are given for determinations of the effects from a succession or combination of step or ramp temperature changes at a fluid-wall boundary. An example is set up for a set of conditions to determine the maximum biaxial thermal stress (away from edge effects) which develops in an 8-ft-i.d. pressure-vessel wall. (B.O.G.)

#### 12695

PROGRESS IN CRYOGENICS. VOLUME 1. K. Mendelssohn, ed. New York, Academic Press, Inc., 1959. 261p.

Methods of producing, maintaining, and measuring low temperatures are summarized. Basic circuits and systems using superconductive devices are discussed. The choice of suitable semiconductors is discussed, and the methods of using them are outlined. The factors influencing heat transport through powders and fibers are analyzed. Low-temperature calorimetry and distillation methods are described. Ultrasonic attenuation and mechanical property measurements in metals at low temperatures are considered. Studies on frozen free radicals and the determination of specific heats by the temperature-wave method are discussed. (C.J.G.)

## Instrumentation

**12696** 60-GL-45

General Electric Co. General Engineering Lab., Schenectady, N. Y.

### THE DESIGN OF A PRECISION CURRENT REGULATOR.

F. N. Peters. Mar. 17, 1960. 75p.

The design, construction, and analysis of a subminiature precision current reference are described. The regulator will maintain a current, constant within a few parts per million, through a varying resistive load. A review of the available literature on the subject is presented which shows that the general trend in previous work of this kind has been toward current stabilization with respect to a varying voltage supply. A detailed analysis of the circuit was made and the results of the analysis were in good agreement with the data obtained from the actual equipment. (W.D.M.)

**12697** ARF-1152-9

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

### AN IMPROVED NUCLEAR MEASURING PRINCIPLE. Quarterly Progress Report No. 3 Covering the Period from December 1, 1959 to March 1, 1960. G. M. Burgwald.

Mar. 28, 1960. 14p. Contract AT(11-1)-745. OTS.

The scintillation counter has proven to be a very valuable research tool, but unfortunately, its ability to meet necessary stability requirements has restricted its use in industrial applications. Several techniques are being investigated which cancel out reasonable variations in detector sensitivity, resulting in improved stability. The general technique consists of alternately measuring the intensity transmitted through the sample and through a calibrated absorber, and difference in intensity causing the calibrated wedge to re-position itself. A comparison of commutating and noncommutating systems is made and other applications of scintillation counter systems are discussed. (For preceding period see ARF-1152-6.) (W.D.M.)

**12698** BLG-41

Brussels. Centre d'Étude de l'Énergie Nucléaire. SPECTROMETRE NEUTRONIQUE A TEMPS DE VOL AVEC OBTURATEUR A FENTES COURBES. (Neutron Time-of-Flight Spectrometer with a Curved Window Chopper). S. Hautecler. Nov. 30, 1959. 34p.

A study was made of the transmission of a neutron burst through a chopper with cylindrical slits. The probability of transmission of the rotor as a function of the neutrons' speed is determined. Other formulas giving the luminosity and the resolution of the spectrometer are also deduced. Finally, the characteristics of a spectrometer for neutron-phonon interaction study are determined. (auth)

**12699** HW-27544

General Electric Co. Hanford [Atomic Products Operation], Richland, Wash.

REAR FACE MONITORING BY TELEVISION. Final Report. W. J. Morris. Apr. 3, 1953. Decl. Mar. 2, 1960. 30p. Contract W-31-109-Eng-52. OTS.

Operations at Hanford frequently require extensive work in contaminated areas, as well as close cooperation between crews in widely separated locations. At present, only audio contact with the job locations is possible in many cases. A remotely operated closed-circuit television system was designed, built, and tested to determine the suitability of such equipment for overcoming these difficulties. (auth)

**12700** HW-63632

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

ULTRASONIC RESIN LEVEL DETECTOR. D. O. Hunter and C. L. Pleasance. Jan. 15, 1960. 22p. Contract AT(45-1)-1350. OTS.

An ultrasonic instrument for measuring the resin level in an ion exchange column was developed. The sensing element is adaptable to remote installation and will withstand hot nitric solutions in gamma radiation fields to  $10^8$  r total dose. Problems encountered in the development, the limitations and capabilities of the instrument are described. Calibrating procedure, operating instructions and notes on circuit operation are included. (auth)

**12701** KAPL-M-GEM-1

Knolls Atomic Power Lab., Schenectady, N. Y.

STAINLESS-INCONEL METAL SORTING DEVICE. G. E. Martin. Mar. 17, 1959. 6p. Contract W-31-109-Eng-52. OTS.

Design of a device to sort 304 or 347 stainless steel and Inconel is described. The device is applicable to other similar combinations. (J.R.D.)

**12702** NAA-SR-4544

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

THE NON-LINEAR BEHAVIOR OF LARGE PERMANENT-MAGNET FLOWMETERS. G. E. Turner. Apr. 1, 1960. 18p. Contract AT-11-1-GEN-8. OTS.

The calibration of two 12-in. permanent-magnet flowmeters for high temperature sodium service revealed a nonlinear flow-output relationship. This nonlinearity was experimentally and analytically shown to be due to the distortion of the magnetic field caused by the eddy-currents flowing in the sodium. Experiments revealed that movement of the electrode location to a position seven inches downstream from the center of the flowmeter section resulted in flow-output curves which were linear within 1% at temperatures greater than 700°F. (auth)

**12703** ORNL-2792

Oak Ridge National Lab., Tenn.

LEVEL TRANSDUCERS FOR LIQUID METALS. R. G. Affel, G. H. Burger, and R. E. Pidgeon. Apr. 28, 1960. 45p. Contract W-7405-eng-26. OTS.

Twenty-two resistance-type, continuously sensing level transducers for use in NaK (56% sodium, 44% potassium) pumps were constructed which gave high reliability. Potentiometer (d-c) strip chart recorders were slightly modified for use with the transducers, and the performance of recorders having 4.5- and 12-sec balance speeds was very good. In a testing apparatus the results were: total range, 8.25 in.; linear range, 7.25 in.; and linearity, 33%. A 2% zero-level shift and ~0.4% maximum-level shift over a NaK temperature range of 300 to 1400°F was observed with a temperature error less than 1.5% over the range 800 to 1400°F using the 1200°F calibration curve. A system resolution of better than 0.030 in. and reproducibility of better than 1% in the test rig was determined. Wetting errors were negligible for NaK temperatures above 600°F and variable when first exposed to NaK below 400°F. On-off level probes were made but not life-tested. It is concluded that they should be reliable if the center conductor does not rupture. Circuit readjustment was not necessary over the range 100 to 1400°F. Of 40 probes, three failed, one because of improper circuit adjustment and two because of defective welds; 16 have operated more than 3000 hr up to 1500°F without failure, and the remainder have operated at all temperatures of interest for various periods without failure. (auth)

**12704** SCTM-38-60(52)

Sandia Corp., Albuquerque, N. Mex.

OSCILLATOR (COMBINATION OSCILLATOR AND TRANS-



DUCER) MODEL OS-1000, PRESSURE-0 TO 15 PSIA.  
Jan. 28, 1960. 7p. OTS.

The osciducer is a silicon transistor oscillator which was wedded to a variable inductance, diaphragm-type pressure transducer. They may be mounted together as a unit or separately for special applications. A description of the tests that were performed to determine if the unit would be adaptable for FM-FM telemetering use is given. The performance of the 0 to 15 psia, 14.5 kc-unit was not entirely satisfactory for three major specifications. (auth)

**12705** SCTM-100-60(13)

Sandia Corp., Albuquerque, N. Mex.

TWO-HOUR TIMER EVALUATION REPORT. R. K. Heck.  
Mar. 30, 1960. 11p. OTS.

A two-hour timer was developed for use in missile telemetering packages. The telemetering system required that the timer be started and stopped remotely, have a running time of at least 2 hours, and provide a 3-second switch closure every 5 minutes, with a failure rate of less than 1 in 20. The development of the timer is reviewed and the performance evaluated. (auth)

**12706** SCTM-101-60(13)

Sandia Corp., Albuquerque, N. Mex.

TIME MARK GENERATOR. R. K. Heck. Mar. 31, 1960.  
10p. OTS.

The performance of the Time Mark Generator, a transistorized unit for recording precision time sequences in conjunction with a microbarograph system, is described. (auth)

**12707** TID-5684

Oak Ridge Gaseous Diffusion Plant, Tenn.

EXPERIMENTAL EVALUATION OF SOURCES OF VARIANCE IN SPECTROMETER MEASUREMENTS. W. G. Hart and L. A. Smith. Dec. 21, 1955. Decl. Mar. 23, 1960. 12p. (KLI-3662). OTS.

As a possible means of expediting reduction of spectrometer variance, a brief study of the sources of variance was conducted. The experiment was designed only to isolate any outstanding source of variance from those already known or suspected, so the major development effort could be directed toward this one. Although the study failed to reveal any single, clearly defined factor, it did show that contributions of some suspected sources were quite small, and that a combination of others were large enough to warrant further improvement effort. (W.L.H.)

**12708** USNRDL-TR-398

Naval Radiological Defense Lab., San Francisco.

NEUTRON FLUX MEASUREMENTS FROM 100 KEV TO 4 MEV WITH A MODIFIED LONG COUNTER. E. Tochilin and R. V. Alves. Feb. 4, 1960. 16p.

Long counter response to neutrons from a 2-Mev positive ion accelerator was investigated with three instruments which were identical except for the thermal shields within their outer cores. These shields consisted of  $B_2O_3$ , Cd, and polyethylene sleeves. For neutron energies ranging from 0.1 to 4 Mev no differences in relative response were observed for the three counters. Measurements made with indium strips placed along the axis of the counter in place of the conventional  $BF_3$  detector showed that the foil technique could significantly extend the intensity range of the counter at no sacrifice in energy response. (auth)

**12709** WT-1721

Office of Civil and Defense Mobilization, Battle Creek, Mich.

EVALUATION OF AERIAL SURVEY METER V-780.  
Robert B. Martin. Nov. 1959. 37p. Project 70.1 [of]  
OPERATION HARDTACK. OTS.

A field evaluation was made of preproduction models of OCDM V-780 radiological survey instruments developed for aerial measurement of ground dose rate. Dose rates were measured by ground-survey teams along predetermined paths; these measurements were compared with corresponding measurements taken by aerial-survey teams. Correlation between the aerial- and ground-survey instrument readings varied up to factors of 10 to 1. The conclusion drawn from this test is that this instrument must undergo a major revision for civil defense application, both in basic design and in details of packaging and component selection. (auth)

**12710** NP-tr-422

REACTOR OSCILLATOR FOR THE DETERMINATION OF MACROSCOPIC ABSORPTION CROSS SECTIONS OF THERMAL NEUTRONS. T. Hurlimann, P. Schmid, and H. Winkler. Translated by R. Hardbottle (U.K.A.E.A. Atomic Energy Research Establishment) from Z. angew. Math. u. Phys. **10**, 438-41 (1959). 5p. JCL.

A description of installation and uses of a reactor oscillator which was installed in the swimming pool reactor SAPHIR is presented. (J.R.D.)

**12711** NP-tr-425

TRANSISTOR MAGNETIC AMPLIFIER. O. A. Kossov. Translated by P. Collins (U.K.A.E.A. Atomic Energy Research Establishment) from Avtomat. i Telemekh. **20**, 988-91 (1959). 7p. JCL or LC.

A simple transistor-magnetic amplifier with switching transistors at its output is described. Combination of transistor and magnetic stages has the advantages of fast response and high gain, and a plane transistor triode working in a switched regime can give the load a power ten times greater than that given by a linear amplifier for the same power dissipation. For control by switching triodes, a magnetic amplifier having cores with rectangular hysteresis loops can be used; circuits for d-c and a-c sources are given. Data are given for an experimental model of this type of magnetic amplifier with two  $\pi 4Y$  triodes and no additional heat dissipators. (D.L.C.)

**12712**

CONCERNING THE PROBLEM OF STEREOSCOPY IN A BUBBLE CHAMBER. CORRECTION FOR REFRACTION. D. Neagy. Acad. rep. populare Romine, Inst. fiz. atomica gi Inst. fiz., Studii cercetari fiz. **9**, 241-9 (1958). (Translated from Referat. Zhur. Fiz. No. 8, abstract No. 17150).

Unlike the cloud chamber, the apparent image produced in a bubble chamber is distorted because of refraction in the liquid in the chamber and therefore an investigation of elements of the image by the method of repeated projection on a moving screen gives only the elements of the apparent image, but not the real one. The author first investigates the distortion of the image, immersed in a transparent medium with a coefficient of refraction  $n$ , when photographing in air under a slight angle of incidence ( $i \sim 10^\circ$ ). Corrections are then given for the refraction in the measurements of the coordinates of the point, the lengths of the tracks, the angles and the radii of curvature, as determined by the method of repeated projection.

**12713**

INSTRUMENTATION. Ralph H. Müller (Los Alamos Scientific Lab., N. Mex.). Anal. Chem. **32**, 63R-7R (1960) Apr.

A review is presented of selected topics in instrumentation and new techniques of interest to the analytical chemist. With few exceptions commercially available instruments are not discussed. The characteristics of

transducers, and photo-multiplier tubes are described. 31 references. (B.O.G.)

# 12714

AUTOMATIC MEASURING DEVICES FOR RADIOACTIVITY. Paul Lerch and Paul Bercier. Bull. soc. vaudoise sci. nat. 67, No. 1, 27-32(1958) July 25. (In French)

An automatic measuring device which allows continuous activity measurements on 4 samples at once is described. The apparatus is provided with three different power supplies: 300 v, 250 ma; 500 to 2000 v, 10 ma; and 250 v, 250 ma. The samples move on disks through four G-M counters provided with separate amplifiers and scalers. Each count requires 30 sec. (D.E.B.)

# 12715

SEMI-ABSOLUTE MEASUREMENT OF RADIOACTIVITY PROVIDED BY SIMULATED BETA STANDARDS. Paul Lerch and Marise Jeap-Wittgenstein. Bull. soc. vaudoise sci. nat. 67, No. 1, 19-26(1958) July 25. (In French)

In certain applications of radioisotopes, it is necessary to know the absolute activity of the substances used. In these cases it appeared expedient to work with simulated standards having much longer half lives but also having activities as close as possible to the true substances. For  $P^{32}$  and  $I^{131}$ , such simulated standards were found and subjected to numerous tests. For  $P^{32}$  with a half life of 14.3 days,  $U^{238}$  with a half life of several million years was taken as a standard in the form of  $U_3O_8$ . For  $I^{131}$ , with a half life of 8.05 days,  $Cl^{36}$  with a half life of  $3.08 \times 10^6$  yr was taken as a standard in the form of NaCl. During the last 5 yr, 145 shipments of  $I^{131}$  were compared with the simulated  $Cl^{36}$  standards and the mean difference was +1.0% with a standard deviation of 13.2%. The 124 shipments of  $P^{32}$  obtained were compared with  $U_3O_8$  and the mean difference was +1.5% with a standard deviation of 5.8%. Standardization was carried out with standard samples from the National Physical Laboratory in Teddington, England, and the NBS in Washington, D. C. (OID)

# 12716

SOME SENSITIVITIES OF ION GAUGES. William McGowan and Larkin Kerwin (Laval Univ., Quebec). Can. J. Phys. 38, 567-9(1960) Apr.

The sensitivities of two ion gages, a Bayard-Alpert type and a standard Macleod gage, were determined by measuring the ion currents of various gases, using argon as a standard. These ion currents were then used to calculate the sensitivity of the respective gas. (C.J.G.)

# 12717

HEAVY PARTICLE DETECTOR WITH n-p SILICON JUNCTION. Georges Amsel, Pierre Baruch, and Olgierd Smulkowski. Compt. rend. 250, 1468-70(1960) Feb. 22. (In French)

The described detector operates at room temperature and has a linear response with a rise time of the order of a millimicrosecond. Insensitive to neutrons and to  $\gamma$  rays, with a high resolution, it allows the selective analysis of complex spectra of  $\alpha$  rays, protons, and deuterons. (tr-auth)

# 12718

SILICON JUNCTIONS DETECT PARTICLES. Electronics 33, No. 17, 74; 76; 78(1960) Apr. 22.

A program was initiated for research and development of silicon pn junctions as particle detectors. The results of collection tests on carriers diffused through the dead layer agree with time-of-flight measurements within the accuracy of both methods. The expected rise time was 2 nsec, and the actual rise time was 1.5 nsec for the sys-

tem. Rise time for fission fragments was 10 nsec, well beyond experimental error. The detectors were made up to  $1 \text{ cm}^2$  in area, with depletion thicknesses to 0.7 mm, negligible dead layers, and exhibited line widths down to 20 kev. (B.O.G.)

# 12719

GAS-FILLED TUBES. H. C. Steiner (General Electric Co., Schenectady, N. Y.). Electronics 33, No. 18, 65-9(1960) Apr. 29.

A review of the developments in cold cathode gas-filled tubes, thyratrons, hydrogen thyratrons, mercury pool tubes, and ignitron tubes is presented. (C.J.G.)

# 12720

STORAGE, COUNTING AND PHOTOTUBES. Arthur S. Kramer (Allen B. DuMont Labs., Inc., East Paterson, N. J.). Electronics 33, No. 18, 86-90(1960) Apr. 29.

A review of developments in multiplier phototubes, camera tubes, storage tubes, counting tubes, and radiation detecting tubes is presented. (C.J.G.)

# 12721

MEASUREMENT OF SMALL NEUTRON FLUX WITH FAST IMPULSE COUNTING CHANNELS. J. J. van Zolingen. Electrotechniek 37, 341-9(1959). (In Dutch)

A description is given of the impulse counting channels in use with the Zero Energy Reactor of the KEMA. An improved flip flop circuit for impulse densities up to  $30 \times 10^6$  imp/sec, which employs a millivolt amplitude discriminator for impulse amplitudes larger than 12 mv, is described. (Reactor Centrum Nederland)

# 12722

METHOD OF MEASURING LARGE NEUTRON FLUX WITH ELECTROMETERS. M. van Tol. Electrotechniek 37, 349-52(1959). (In Dutch)

A description of the instrumentation used with the KEMA sub-critical suspension reactor for measuring neutron flux values ranging from  $2 \times 10^3$  to  $2 \times 10^6$  neutrons per  $\text{cm}^2$  per second is given. (Reactor Centrum Nederland)

# 12723

GENERATOR OF SUPERSTRONG PULSED MAGNETIC FIELDS. I. G. Fakidov and E. A. Zavadskii (Inst. of Metal Physics, Academy of Sciences, USSR). Fiz. Metal. i Metalloved. 8, 562-8(1959) Oct. (In Russian)

The design is given of a generator (GSMP) producing magnetic fields up to 700,000 gauss by means of a condenser battery discharge. The energy specifications, electric scheme, and coil constructions are described. (tr-auth)

# 12724

AUTOMATIC CLOUD CHAMBER FOR THE INVESTIGATION OF COSMIC RAYS. Karoly Kantor and Kalman Zsdanszky. Magyar Fiz. Folyóirat 6, 191-208(1958). (Translated from Referat. Zhur. Fiz. No. 8, 1959, abstract No. 17148).

A thorough study is made of problems of the construction, preparation, and adjustment of an automatic cloud chamber, controlled by Geiger-Mueller counters. The separate units of the chamber and the control circuits are described.

# 12725

A PORTABLE BLOCK FOR TISS RADIOMETER FOR MEASURING SOFT  $\beta$ -RADIATION. A. F. Sobol and Yu. V. Seredin. Med. Radiol. 5, No. 2, 72-3(1960) Feb. (In Russian)

The construction of a portable shield for a radiometer which employs soft  $\beta$ -radiation to measure the pollution level of radioactive isotopes is described. (auth)



**12726**

RADIOACTIVE SELF-LUMINOUS COMPOUNDS. II. A SIMPLE METHOD FOR DETERMINING  $\beta$ -ACTIVITY OF MICROCURIE ORDER IN SELF-LUMINOUS COMPOUNDS. Yasuro Atō and Ryōichiro Fujimura. Nagoya Kōgyō Gijutsu Shikensho Hōkoku 8, 527-32(1959) July. (In Japanese)

An aperture was used to reduce the number of  $\beta$  particles arriving at an end-window-type Geiger-Mueller counter. The aperture, an Al plate having a hole at its center, was inserted between the sample and the counter.  $S^{36}$ ,  $Ca^{45}$ ,  $Tl^{204}$ ,  $P^{32}$ , and  $Sr^{90}-Y^{90}$  were employed as  $\beta$  sources. The reduction coefficients of apertures with various geometrical factors such as thickness, diameter, and location were determined for each isotope. Graphical data showing the relationship between the reduced counting rate and the radioactivity are given. The measurable level for  $Tl^{204}$  was 500  $\mu$ c max with an error of less than 20%. (OID)

**12727**

AN INEXPENSIVE CASTLE AND SAMPLE HOLDER FOR RADIOACTIVE COUNTING. Howard Boroughs (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). Nature 186, 145-6(1960) Apr. 9.

The design is described of an inexpensive wooden holder for Geiger-Mueller tubes. (C.H.)

**12728**

ENERGY DEPENDENT INSTRUMENTAL TIME DELAYS IN MILLIMICROSECOND DELAYED COINCIDENCE EXPERIMENTS. Ekbal Bashandy (Inst. of Physics, Uppsala). Nuclear Instr. and Methods 6, 289-95(1960) Mar. (In English)

An experimental study of energy dependent time delays present in delayed coincidence measurements was performed. The most important factor was found to be due to the time lag between the excitation of the scintillator and the appearance of the first few photoelectrons used to trigger the coincidence circuit. These time delays are of the order of  $10^{-10}$  sec and may introduce serious systematic errors when submillimicrosecond lifetimes are to be measured by the centroid displacement method. It is shown that these errors can be eliminated by making use of an electron-electron coincidence spectrometer. (auth)

**12729**

THE ACTION OF FAST SPHERICAL IONIZATION CHAMBERS. R. D. Connor (Univ. of Manitoba, Winnipeg). Nuclear Instr. and Methods 6, 301-8(1960) Mar. (In English)

Theoretical equations are presented representing the formation of pulses in fast spherical ionization chambers, with special reference to pulse height as a function of the position of the ionizing event in the chamber. The calculations are extended to ionizing tracks of finite length and it is seen that the pulse height is relatively independent of the position of the track. Wall effects and the performance of a hydrogen filled chamber under neutron irradiation are discussed. (auth)

**12730**

ON THE MECHANISM OF MULTIPLE DISCHARGES IN SELF-QUENCHING GEIGER COUNTERS. O. J. Orient (Central Food Research Inst., Budapest). Nuclear Instr. and Methods 6, 309-22(1960) Mar. (In English)

Multiple pulses occurring in the plateau and breakdown region of pure ethyl alcohol as well as ethyl alcohol-argon gas mixture filled counter tubes were studied. A single sweep oscilloscope was used to investigate the shape and the time of appearance of multiple discharges. In pure

ethyl alcohol filled tubes the plateau slope and the breakdown region were due to multiple pulses of the same order of magnitude as the "ordinary" pulses. These multiple pulses were produced always immediately after the recovery time. The same process was observed for ethyl alcohol-argon gas mixture filled tubes. Pulses responsible for the breakdown region were much smaller and occurred after the dead time. The two kinds of multiple pulses may be discriminated electronically and counted separately. These experiments too have shown only "high" pulses occurring in the plateau region whereas at the termination of the plateau region, in the breakdown section for ethyl alcohol-argon gas filling the number of "low" multiple pulses was much higher than that of "high" multiple pulses. According to measurements the "high" multiple pulses result from processes occurring on the cathode surface while the "low" multiple pulses are due to processes in the gas volume. It is assumed that the "high" multiple pulses are caused by the decay of organic gas molecules returning to ground state in the vicinity of the cathode and the "low" ones may be attributed to the decay of metastable argon molecules remaining after the dead-time. The values calculated according to this theory for the plateau and breakdown region of the counters were in good agreement with the experimental results. (auth)

**12731**

MILLIMICROSECOND PULSING—ITS APPLICATION AND TECHNIQUE. W. M. Good (Oak Ridge National Lab., Tenn.). Nuclear Instr. and Methods 6, 323-30(1960) Mar. (In English)

A terminal pulsed Van de Graaff Generator is capable of delivering 500  $\mu$ A and more peak currents in bursts 2-10 millimicrosecond time duration at arbitrary repetition rates. It is shown how millimicrosecond intervals of time relative to these bursts can be measured and recorded. Applications of such measurements to nuclear physics are given. Some of the problems encountered in producing bursts of ions at the terminal of a Van de Graaff are outlined by considering the application of a simple sinusoidally varying voltage to obtain bursts. It is shown that existing techniques can be improved substantially in a number of ways. (auth)

**12732**

DETECTION OF LOW ENERGY NEUTRONS WITH A NaI(Tl) CRYSTAL AND TIME OF FLIGHT. R. Ballini (Centre d'Études Nucléaires, Saclay, France) and S. M. Shafroth (Northwestern Univ., Evanston, Ill. and Centre d'Études Nucléaires, Saclay, France). Nuclear Instr. and Methods 6, 331-6(1960) Mar. (In English)

A NaI(Tl) crystal was substituted for a plastic scintillator in conventional neutron time of flight apparatus. The characteristics of this neutron detection system were studied using pulsed low energy neutrons from the  $Li^7(p,n)$  reaction. Neutron groups were resolved down to 30 kev with reasonable efficiency. The method should prove useful in studying low energy neutron spectra resulting from nuclear reactions. (auth)

**12733**

SOME FACTORS AFFECTING THE GAIN AND RESOLUTION OF PHOTOMULTIPLIER TUBES. R. D. Connor and M. K. Husain (Univ. of Manitoba, Winnipeg). Nuclear Instr. and Methods 6, 337-42(1960) Mar. (In English)

Changes in the gain and resolution of photomultipliers of the DuMont type are examined with reference to changes in counting rate, axial magnetic fields, and temperature. While the magnitudes of these variations are found to vary as between photomultipliers, graphs are given showing

typical dependences. The effects of magnetic shielding are presented and the variation of resolution with  $\gamma$ -ray energy in scintillation counters equipped with large NaI crystals is discussed in the light of recent statistical considerations. (auth)

# 12734

SYSTEM OF SUBTRACTION WITH CATHODE-RAY TUBE MEMORY. A. Boucherie (Centre d'Études Nucléaires, Saclay, France). Nuclear Instr. and Methods **6**, 354-6 (1960) Mar. (In French)

This paper describes a method whereby a digital subtracting system by the means of a memory cathode-ray tube is obtained. This system can be associated with a pulse height analyzer which uses the principle of storing pulses along vertical lines on the screen of a memory cathode-ray tube and analyzing them by horizontal scanning. It leads to a simple way of direct convection of the integral spectrum given by the scanning into a differential spectrum. (auth)

# 12735

A NUCLEAR MAGNETIC RESONANCE SPECTROMETER. V. J. Kowalewski and R. A. Hoffman (Univ. of Uppsala). Nuclear Instr. and Methods **6**, 357-60 (1960) Mar. (In English)

The design and performance of a bridge and pre-amplifier system for observation of nuclear magnetic resonance at various frequencies is described. (auth)

# 12736

A PROPOSAL TO DECREASE THE DEADTIME OF THE HUTCHINSON-SCARROT TYPE PULSE HEIGHT ANALYSER. W. S. C. Williams (The University, Glasgow). Nuclear Instr. and Methods **6**, 361 (1960) Mar. (In English)

A method is presented for reduction of the deadtime in a pulse height analyzer by a factor equal to the number of channels. This is to be accomplished by inserting a temporary store between the input and the normal circulating binary store. The advantages and functioning of the temporary store installed in the analyzer are discussed. (B.O.G.)

# 12737

HEALTH PHYSICS INSTRUMENTATION. [PART] I. Denis Taylor (Plessey Nucleonics Ltd., Northampton, Eng.). Nuclear Power **5**, No. 48, 147-8 (1960) Apr.

The classification and uses of the types of instruments used by health physics personnel for radiation monitoring are given. The classification may be: instruments to determine external exposure to which personnel may be exposed; instruments for evaluation of radioactivity on personnel, clothing, apparatus, benches, floors, in liquids or gases; and instruments for the determination of radioactive materials deposited within individuals. A diagram is given for instruments located at advantageous points around a reactor. (B.O.G.)

# 12738

CONTINUOUS COUNTING OF GAMMA RAYS FROM HOT RADIOACTIVE LIQUIDS. Farno L. Green and A. Somerville (General Motors Corp., Warren, Mich.). Nuclear Sci. and Eng. **7**, 320-2 (1960) Apr.

A standard NaI (Tl) scintillation crystal is used to count continuously gamma rays from Fe<sup>59</sup> dispersed in lubricating oil at 270°F. The crystal is mounted in a water-cooled jacket which also serves as a light shield and the assembly is placed in a well-type sample holder. Resolution is adequate for counting two gamma rays. The temperature of the electronics cabinet is maintained at 105°F by Nichrome heater elements. Less than 1% drift occurs when the tem-

perature surrounding the cabinet varies from 70 to 100°F. (auth)

# 12739

TRANSISTOR PULSE GENERATOR. Edwin Gordy and George Sieber (Roswell Park Memorial Inst., Buffalo). Nucleonics **18**, No. 4, 90; 92 (1960) Apr.

The circuitry and performance characteristics are given for a transistor pulse generator designed to produce test pulses for checking amplifiers, scalars, counting-rate meters, and pulse-height analyzers associated with G-M and scintillation detectors. The generator frequency is stable to better than 0.5% at laboratory ambient temperatures. (B.O.G.)

# 12740

NEW GLASS DOSIMETER IS LESS ENERGY-DEPENDENT. R. J. Ginther and J. H. Schulman (U. S. Naval Research Lab., Washington, D. C.). Nucleonics **18**, No. 4, 92; 95 (1960) Apr.

A newly developed radiophotoluminescent Mg-Li-Al-Ag phosphate glass has a sensitivity to low-energy gamma rays one-third that of Ba-K-Al-Ag phosphate glass used in the dosimetry system of the U. S. Navy. The lithium is expected to provide an enhanced thermal-neutron sensitivity over that of the older glass. (B.O.G.)

# 12741

FADING OF MINIMUM TRACKS IN ILFORD G-5 AND K-5 EMULSIONS. B. Judek (National Research Council, Ottawa). Nuovo cimento (10) **15**, Suppl. No. 2, 161-6 (1960). (In English)

The fading of plateau electron tracks in Ilford G-5 and K-5 emulsions, stored after exposure at temperatures of 20, -1, -18, and -40°C, was compared. It was found that the same initial grain densities are obtained on tracks in both G-5 and K-5 emulsions with identical development one day after the exposure, while the rate of fading is lower in K-5 than G-5 emulsions. The results show that the rates of fading in both emulsions are much higher at 68°F than at the lower temperatures. After four weeks at 20°C there is a marked effect, the reduction in blob densities being 41% in G-5 and 38% in K-5 emulsions. In emulsions stored at 0°F even for 2.5 months after the exposure, easily recognizable electron tracks were obtained with blob densities reduced by only 18 and 13.5%, respectively. No significant difference between the rates of fading at -1, -18, and -40°C could be detected. It was found that fading is much more rapid during the first two weeks after the exposure than during a later period. (auth)

# 12742

A SIMPLE FINDER ATTACHMENT TO A MICROSCOPE. USEFUL IN THE EXAMINATION OF GRID-BACKED NUCLEAR EMULSION PLATES, OR GLASS SLIDES. W. B. Lasich (University Coll., London). Nuovo cimento (10) **15**, Suppl. No. 2, 166-8 (1960). (In English)

A microscope attachment which facilitates the reading of the position coördinates associated with nuclear events located in photographic emulsions is described. By diversion of light into a small finder telescope an image corresponding to the plane of the reference grid may be independently sighted, thus eliminating the need for readjustments of the microscope. (auth)

# 12743

MODEL EXPERIMENTS ON THE DESIGN OF SOLID IRON MAGNETS FOR USE IN COSMIC RAY SPECTROGRAPHS. H. W. Bennett (Coll. of Advanced Tech., Loughborough, Eng.) and W. F. Nash (Univ. of Nottingham, Eng.). Nuovo cimento (10) **15**, Suppl. No. 2, 193-201 (1960). (In English)



The high magnetic field available in a magnetized block of iron may be used to measure the momentum of non-interacting particles such as  $\mu$ -mesons, provided that the line integral of the magnetic induction is known with sufficient accuracy. Model picture frame magnets were constructed in order to investigate the effects of geometry and of degree of magnetization on the uniformity of the magnetic induction. The relative merits of passing the particles through the energizing coils or the open ends are considered. It is found that high inductions, with uniformity of  $\pm 3\%$ , may easily be obtained over 90% of the available volume for comparatively low power dissipation. (auth)

#### 12744

THE CHARACTERISTICS OF A SOLID IRON MAGNET FOR USE IN A COSMIC RAY SPECTROGRAPH. P. V. O'Connor and A. W. Wolfendale (Univ. of Durham, Eng.). Nuovo cimento (10) 15, Suppl. No. 2, 202-10(1960). (In English)

Many advantages are gained by deflecting weakly interacting cosmic rays in magnetized iron instead of the conventional air gap of an electromagnet. A solid iron magnet was constructed in the form of a rectangular transformer core with excitation windings on opposite sides of the core. The design is based on the results of model experiments by Bennett and Nash on the variation of induction throughout the iron and the leakage field above and below the magnet. When the magnet is operated at a power of 2 kw (mean  $\int Bdl = 982$  kg cm), the variation of integrated magnetic induction for vertical particle trajectories, is less than  $\pm 3\%$ . (auth)

#### 12745

A COMPACT PROCESSING PLANT FOR THICK NUCLEAR EMULSIONS. J. E. Hooper, E. Dahl-Jensen, and E. B. Neergaard (Univ. of Copenhagen). Nuovo cimento (10) 15, Suppl. No. 2, 211-35(1960). (In English)

A compact processing plant for large nuclear emulsion stacks is described. A wet development procedure, which was found to yield satisfactory results is discussed, together with certain more specific problems, such as the surface deposit of silver and the rate of silver removal from the emulsion during fixation. (auth)

#### 12746

CONTROLLED SENSITIVITY BUBBLE CHAMBER WITH STABILIZED FINAL PRESSURE. B. Hahn, A. W. Knudsen, and E. Hugentobler (Universität, Freiburg i. B.). Nuovo cimento (10) 15, Suppl. No. 2, 236-45(1960). (In English)

A radiation sensitivity stabilized 2-liter bubble chamber operating with  $CBrF_3$  or fluorocarbon gas-liquid mixtures near room temperature is described. Final pressure stabilization is achieved by a method first suggested by Blinov et al. Flat bottomed pressure pulses 30 ms long, and corresponding bubble density plateau with bubble density variations smaller than  $\pm 5\%$  were obtained. The chamber sensitivity is reproducible at any time and can be adjusted instantaneously to the desired bubble density. The chamber is also temperature stabilized. Accurate bubble counting for particle velocity determinations is possible without reference track in each bubble chamber picture. A discussion is presented, on how to minimize undesired pressure oscillations, and on the possibility to pressure stabilize much larger chambers. (auth)

#### 12747

AN OPTICAL-MECHANICAL METHOD FOR STEREOSCOPIC RECONSTRUCTION. E. Fiorini and S. Ratti (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo cimento (10) 15, Suppl. No. 2, 246-53(1960). (In Italian)

A stereoscopic optical-mechanical method for reconstruction of cloud and bubble chamber events is described. This method consists essentially of a material reconstruction of events. A stereoscopic apparatus, based on the method, is at present used to reconstruct multiplate Wilson chamber events. The performance of the apparatus is described and the errors of measurement estimated. The simplicity, quickness of reconstruction and the possibility of space visualizing reconstructed events make of this apparatus a valuable help in cloud and bubble chamber researches. (auth)

#### 12748

THE HIGH FREQUENCY PROPERTIES OF A COAXIAL CABLE AND THE DISTORTION OF FAST PULSES. G. Fidecaro (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 15, Suppl. No. 2, 254-63(1960). (In English)

The high frequency properties of a coaxial cable and the distortion of fast pulses are discussed. A convenient way of determining accurately the delay of a coaxial cable is shown. (auth)

#### 12749

THEORY OF A HIGH-RESOLUTION BETA-RAY SPECTROMETER WITH HIGH LUMINOSITY. H. Daniel (Iowa State Univ. of Science and Tech., Ames). Rev. Sci. Instr. 31, 249-52(1960) Mar.

Second-order perturbation theory was used to calculate the electron orbits in a "flat" beta-ray spectrometer with an azimuth-independent magnetic field having a symmetry plane. Abandoning first-order  $z$  focusing, it is possible to obtain a much higher resolution at a given transmission compared with the usual  $\pi\sqrt{2}$  instrument. The resolution depends, in the lowest power, only on fourth-order terms of the radial and axial emission angles. The resolution does not depend on the first power of the source height. The focusing principle is applicable for a set of angles  $\theta$ , and the dispersion increases strongly with increasing angle. Several examples are discussed. (auth)

#### 12750

SCINTILLATION TYPE MASS SPECTROMETER ION DETECTOR. N. R. Daly (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Rev. Sci. Instr. 31, 264-7(1960) Mar.

A new and relatively simple type of mass spectrometer ion detector is described. The positive ion is accelerated onto an aluminum surface releasing secondary electrons, and these in turn are accelerated onto an organic scintillator, viewed by a sealed-off photomultiplier. Counting methods are used to measure the ion beams. The detector has a low noise level,  $4 \times 10^{-20}$  amp, and the mass discrimination is small for ions in the high and low mass range. Admission of air to the vacuum system does not affect the gain of the detector, since no activated surfaces are situated within the vacuum. In the event of a fault occurring in the photomultiplier a new one can be substituted in a few minutes without letting air into the vacuum system. (auth)

#### 12751

RESISTANCE-HEATED HIGH VACUUM FURNACE FOR TEMPERATURES TO  $1400^\circ\text{C}$ . Julius Cohen (Sylvania Research Labs., Bayside, N. Y.). Rev. Sci. Instr. 31, 267-70(1960) Mar.

An experimental high vacuum furnace with a platinum-rhodium resistance heating element is described; it is operable also in oxygen or other gases up to pressures of at least  $10^{-3}$  mm Hg. The furnace is assembled from

readily obtainable equipment, and knife-edge vacuum seals are used throughout. The uniform hot zone is approximately  $1\frac{9}{32}$  in. in diameter and 2 in. long. The power required for 1400°C, the maximum safe operating temperature, is about 1 kw; at this temperature the pressure is  $\sim 10^{-8}$  mm Hg. This furnace is suitable for electrical conduction studies as well as for heat treatment, etc. (auth)

**12752**

SOME PROPERTIES OF A GRADED VACUUM SPARK GAP. J. W. Mather and A. H. Williams (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr. **31**, 297-303 (1960) Mar.

A high power, low inductance vacuum spark gap combination (crowbar and main switch) is described which is capable of d-c operation over a wide voltage range. The electrical properties are discussed in regard to shorting and multiple switch operation. The principal difficulty of vacuum spark gaps, the coating of the inner surface of the insulator with evaporated and sputtered electrode material, is absent in this design after conditioning. A mechanism to account for this, based on the establishment of a large number of nucleation centers on the insulating walls, is shown to be consistent with observation. (auth)

**12753**

GAUGES FOR CHECKING DIMENSIONAL AND ELECTRICAL MATING OF QUARTZ-FIBER RADIATION DOSIMETERS AND THEIR CHARGERS. A. C. Clark and G. E. Davis (Naval Material Lab., Brooklyn). Rev. Sci. Instr. **31**, 345-6 (1960) Mar.

A description is presented of gages for checking dimensional and electrical mating of quartz-fiber dosimeters and chargers. The unique design features of these two gages can be used in various forms for checking or measuring load-controlled dimensions of instruments under predetermined forces. (B.O.G.)

**12754**

SLIDE RULE FOR THE PRESSURE CORRECTION OF COSMIC RAY DATA. J. R. Storey and K. G. McCracken (Univ. of Tasmania, Hobart). Rev. Sci. Instr. **31**, 347-8 (1960) Mar.

A slide rule is described which was designed for use in correcting for pressure in cosmic-ray data. It was proposed to use a logarithmic equivalent of the counting rates and add a scale to the rule, calibrated with the logarithm of the counting rate, which would enable direct conversion of this logarithmic form to the pressure corrected form. (B.O.G.)

**12755**

PLASTIC-TO-METAL VACUUM SEAL FOR ROTATING TARGETS. H. Toffer and R. L. Amrein (Argonne National Lab., Lemont, Ill.). Rev. Sci. Instr. **31**, 348-9 (1960) Mar.

A plastic-to-metal vacuum seal for rotating targets is described. It was found that a Tenite II seal ring running against the lapped face of the Meehanite cast iron stationary back plate yielded the best results. The advantages of this plastic used as the sealer are given. No wearing was detected except under the microscope after 76 hr operation at 137 rpm. A vacuum of  $1 \times 10^{-5}$  to  $5 \times 10^{-6}$  mm Hg was maintained during the operation. (B.O.G.)

**12756**

MERCURY FLOAT VALVE. Zlatko Knor (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Rev. Sci. Instr. **31**, 351 (1960) Mar.

A float valve is described which is a modified Stock's valve with a special mercury reservoir. The valve is suitable for apparatus working in the pressure range 760

to  $10^{-8}$  mm Hg, especially when the vapors of organic compounds have to be eliminated completely, or for work with radioactive gases (tritium). (B.O.G.)

**12757**

DETECTION OF ALPHA PARTICLES WITH COMMERCIALY AVAILABLE TRANSISTORS. Avivi I. Yavin (Univ. of Illinois, Urbana). Rev. Sci. Instr. **31**, 351-2 (1960) Mar.

Commercially available transistors were used as alpha particle detectors for magnetic analysis of reaction particles. The attractive features of these detectors are that they are small and are more efficient than either gas ionization chambers or scintillators in converting particle energy into detected charge. Photographs of the oscilloscope pattern for  $\text{Pb}^{212}$   $\alpha$  pulses from a 2N170 detector and a phototransistor are shown. The signal-to-noise ratio was 75:1, the limit of which was set by the amplifier noise. A decrease of 40% occurred in the pulse heights when the room lights were turned off and changing the emitter-collector bias from 6 to 12 v did not affect the pulse heights. (B.O.G.)

**12758**

APPARATUS FOR NEUTRON DIFFRACTION STRUCTURAL ANALYSIS. I. I. Yamzin (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. **4**, 397-9 (1960) Mar.

A description is presented of the design and characteristics of an apparatus for neutron diffraction structural analysis. It is based on the principle of the two-crystal spectrometer, comprising a collimator, crystal monochromator, spectrometer, and recording apparatus. The resolving power and "luminosity" of the instrument is shown by a plot of the spectra of reflections from the (100) planes of a KCl crystal one  $\text{mm}^3$  in volume. (B.O.G.)

**12759**

MAGNETIC IONIZATION MANOMETER. V. M. Gavriluk (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur. **4**, 679-81 (1959) Sept.-Oct. (In Ukrainian)

Descriptions are given of a high-sensitivity magnetic ionization manometer capable of measuring pressures between  $10^{-4}$  to  $2 \times 10^{-6}$  mm mercury. (R.V.J.)

**12760**

THE PROCESSES IN A FAST BUBBLE CHAMBER. Claus Andelfinger (Technische Hochschule, Munich). Z. angew. Phys. **12**, 99-107 (1960) Mar. (In German)

A bubble chamber operating with two distinct expansion systems is described. The slow system operates with an average time pressure variation of  $dp/dt = 7.5 \times 10^3$  atm/sec. This is an order of magnitude usual in bubble chambers. With the fast system a  $dp/dt = 2.5 \times 10^6$  atm/sec is obtained. In the slow relaxation the dependence of the radiation sensitivity on the liquid pressure was measured at the moment of the irradiation. This shows that the radiation sensitivity in a pressure interval of 5 atm  $\pm 10\%$  decreases from a maximum to zero. The fast expansion system operates on the principle of the shock tube. The relaxation was initiated by a rupturing metallic membrane. Rarefaction waves, which are propagated with the velocity of sound, arise. The velocity is of the order of 3 to  $4 \times 10^4$  cm/sec. By pressure measurements at three distinct points of the chamber, the time and spatial pattern of the pressure in the first bubble chamber was determined. The sensitive time is around 250  $\mu\text{sec}$  in comparison with 2.5 msec in the slow chamber. The investigation showed that the lifetime of the bubble nuclei in the non-expanded chamber is less than 10  $\mu\text{sec}$ . (tr-auth)



**12761**

California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Donner Lab. SCINTILLATION CAMERA AND POSITRON CAMERA. Hal O. Anger and Donald J. Rosenthal. p.59-82 of "Medical Radioisotope Scanning. Proceedings of a Seminar Jointly Organized by the International Atomic Energy Agency and the World Health Organization, Vienna, February 25-27, 1959." (In English)

A short description is given of earlier forms of the gamma-ray camera. The principle of operation of the scintillation camera is reviewed. Here the locations of scintillations occurring in a flat thallium-activated sodium iodide crystal are determined from the amount of light picked up by a number of phototubes simultaneously viewing the crystal. The signals from the phototubes are fed to a deflection computer circuit which reproduces the scintillation on a cathode-ray tube screen. There they are photographed by a conventional scope camera. Examples are shown of the resolution now obtained as shown by test phantoms. A discussion is presented of the camera's use in visualizing the thyroid in clinical practice. (auth)

**12762**

A NEW SCINTILLATION COUNTER FOR BETA PARTICLES OF SHORT PENETRATION IN WATER AND ITS APPLICATION IN RADIO-CHROMATOGRAPHY.

E. Schram and R. Lombaert. p.626-36 of "International Conference on Radioisotopes in Scientific Research 1, Paris, 1957." New York, Pergamon Press, 1958. (In French)

Applications of  $S^{35}$  and  $C^{14}$  in biology is difficult because of the very low energy of the  $\beta$  particles, their low penetration, and the self absorption in an aqueous medium. These difficulties were overcome by using an apparatus designed to spread the radioactive liquid in a thin layer over a higher surface area in contact with a plastic scintillator. The detector consists of a small cell, which has a relatively large surface, a capacity of about 1 ml, and walls of the scintillating material 0.3 mm apart. Auxiliary equipment includes 2 photomultipliers and a rate meter coupled to a scaler. This apparatus permits direct measurements of solutions or biological preparations, continuous or discontinuous operation, and greater precision than with thin window Geiger-Müller counters. Constant geometry, absence of contamination, nondestructive testing, and the lack of disturbances caused by non-volatile residues are other advantages. (OID)

**12763**

LIQUID SCINTILLATORS FOR THE IMPREGNATION OF CHROMATOGRAPHIC PAPER IN MEASURING SOFT BETA RADIATION. J. C. Roucayrol, E. Oberhausen, and R. Schuler. p.648-62 of "International Conference on Radio-isotopes in Scientific Research, 1, 1957." New York, Pergamon Press, 1958. (In French)

In chromatography or electrophoresis, radioactive substances are often collected on filter paper, but their activity is difficult to determine when soft  $\beta$  particles are involved. To overcome this difficulty, it is suggested that the filter paper be impregnated with a liquid scintillator, such as a solution of phenylbiphenyloxadiazole in toluene (8 g/l). Then the energy of the particles, which otherwise would be lost in the paper, produces scintillations which can be easily detected with a photomultiplier. The sensitivity of the photomultiplier to  $\beta$  particles of  $C^{14}$  or  $S^{35}$  is about 100 times greater than that of a G-M counter which has a mica window and is 5 mm from the sample.

With a given quality of filter paper and a constant activity, the number of counts/min is constant, but with different quality papers the counts/min may vary by up to 30%. (OID)

**12764**

PHOTOGRAPHIC FILM FOR GAMMA-RAY MONITORING. K. Murofushi and Y. Wakabayashi. p.129-30 of "Aisotōpu Kenkyū Riyō Sōran, 1956." Tokyo, Japan Atomic Energy Industrial Association, 1957. (In Japanese)

Energy characteristics, stabilities, and latent image effects of "Sakura" badge film and a similar foreign-made film were compared for  $\gamma$  radiation. The qualities of both films were similar. Waterproofing of the film in packaging was important. Experimental results are graphed. (OID)

**12765**

SOME EXAMPLES OF THE USE OF THE "POTENTIO-STAT" IN STUDY ON THE BEHAVIOUR OF METALS IN LIQUID MEDIA. Ph. Berge (Ministère de la Marine, Paris) and P. A. Jacquet (Commissariat à l'Énergie Atomique, Paris). p.175-84 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Using the potentiostat described by M. H. Roberts (*Brit. J. Appl. Phys.*, 5, 351-52(1954)), it is possible to hold constant all values of the potential of an immersed metallic electrode, no matter what the variations of intensity brought about by the evolution of the electrode surface and the electrolyte. A brief description is given of a potentiostat modified by the addition of an automatic recording device and of a movable cell for non-destructive experiments on samples. Two types of application are foreseen: the analysis of curves showing the variation of polarization potential with intensity; and the analysis of curves for deducing the value of potential which when applied very often makes it possible to control micrographic attacks in very precise manner. Thus in the case of a polyphase alloy the dissolving action can be selectively localized so that it acts on one of the phases even if this phase only represents a very small proportion of the alloy. (auth)

**12766**

IMPROVEMENTS IN OR RELATING TO ELECTROMAGNETIC FLOWMETERS. John Arthur Shercliff (to United Kingdom Atomic Energy Authority). British Patent 831,226. Mar. 23, 1960.

An electromagnetic flowmeter which uses rotating magnets instead of electrodes is described. As in some electromagnetic flowmeters, a magnetic field is imposed transversely to the flow direction. The circulating currents set up at the edge of the field have the effect of weakening the field at the upstream edge and strengthening the field downstream. This distortion produces a force which acts on the magnets arranged on a wheel to cause the wheel to turn at a rate proportional to flow. (T.R.H.)

**Materials Testing****12767** HW-50660

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

ORGANIC RECIRCULATION APPARATUS 2. ORA-2 OPERATING HISTORY, SEPTEMBER 1956-MARCH 1957. C. L. Buckner. June 7, 1957. Decl. Feb. 25, 1960. 13p. OTS.

The operating performance of an organic recirculation apparatus fabricated and operated to make organic radiation decomposition products (tars) is described. The properties of these organic-tar mixtures were evaluated in out-of-pile corrosion and heat transfer loops. Data were obtained on the rate of radiation decomposition, viscosity changes, and radioactivity build-up and decay. (auth)

**12768** AEC-tr-4021

AUTOMATIC ULTRASONIC TESTING OF WELDS. Ultra-son Onderzoek Geautomatiseerd Voor Lascontrole). A. de Sterke. Translated for Oak Ridge National Lab. from *Lastechnik (Hague)* 25, 240-1(1959). 8p. (Includes original, 3p.). JCL.

An ultrasonic method of testing long weldments such as those occurring in large diameter pipes welded with an automatic electric arc is described. (J.R.D.)

**12769** AEC-tr-4024

COMPARISON OF THE RADIOGRAPHIC AND THE ULTRASONIC INVESTIGATION OF JOINTS IN GAS PIPE LINES. (Vergelijking van Radiografisch en Ultra-son Onderzoek van Lassen in Gastransportleidingen). G. J. Janssen. Translated for Oak Ridge National Lab. from *Lastechnik (Hague)* 25, 248-50(1959). 10p. (Includes original, 4p.). JCL.

Radiographic and ultrasonic inspections of welded gas pipe joints are described, and the advantages of the ultrasonic method are outlined. It is noted that while the ultrasonic method requires more skill; it offers better control, especially for detection of cracks and other defects; lower operating costs; and fewer delays. (J.R.D.)

**12770** AEC-tr-4045

CONSIDERATIONS ON THE USE OF ULTRASONICS IN THE NON-DESTRUCTIVE INSPECTION OF WELDINGS. (Considerazioni Sull'impiego Degli Ultrasuoni Nel Controllo Non Distruttivo Delle Saldature). Angelo Brioni. Translated for Oak Ridge National Lab. from *Calore* No. 2, 73-83(1959). 30p. (Includes original, 11p.). JCL.

The possible use of ultrasonics in weld inspection is examined and found to be favorable. Factors influencing the amplitude and location of the echoes are listed, e.g., surface and nature of the defect. Analysis of defects is accomplished through comparison between the form of the echo and the position of the defect. Procedures using inclined transducers are developed to the point where they can be used in a preventive function, that is, they can reveal possible defects and then radiograms can be used to decide which are real defects. On the average, 70% of such radiograms revealed real defects, while the rest revealed only irregularities of the shape of the weld. Two sheet welds with defects previously determined by radiography are analyzed ultrasonically. The speed of ultrasonics relative to radiography is pointed out. (D.L.C.)

## GEOLOGY, MINERALOGY, AND METEOROLOGY

**12771** RME-2020(Rev.)

Grand Junction Operations Office. Salt Lake Branch Office, AEC.

URANIUM OCCURRENCE AT THE CRESCENT MINE, SHOSHONE COUNTY, IDAHO. H. W. Norman. Dec. 1958. 18p.

The Crescent mine, owned by the Bunker Hill and Sullivan Mining and Concentrating Company, is located in the

Coeur d'Alene mining district, Shoshone County, Idaho. A radiometric survey in December 1952 revealed high radioactivity in a narrow zone on the Hooper tunnel level. A channel sample taken across the richest 5 feet of the zone assayed 0.60 percent  $U_3O_8$ . Levels above and below the Hooper tunnel were inaccessible, at least in the area of the projected radioactive zone. In November 1953, a long-hole drilling project was carried out in the radioactive zone of the Hooper tunnel level. Results were generally negative although the zone was delineated by radiometric probing of the holes. (auth)

**12772** SCTM-394-59(51)

Sandia Corp., Albuquerque, N. Mex.

ATMOSPHERIC MOISTURE DATA FOR THERMAL ATTENUATION PROBLEMS. B. N. Charles. Dec. 7, 1959. 12p. OTS.

Data on the climatic distribution of mean daily vapor pressure over Eurasia are presented. The emphasis is on minimum mean ambient vapor pressure, which is found to be as small as 0.2 millibar in some locations during winter. (J.R.D.)

**12773** TEI-642

Geological Survey, Washington, D. C.

ENGINEERING GEOLOGY BEARING ON HARBOR SITE SELECTION ALONG THE GULF OF ALASKA FROM POINT WHITSHED TO CAPE YAKATAGA, ALASKA. Reuben Kachadoorian. Dec. 1959. 32p., 11 illus. OTS.

An analysis of the known geologic factors in the Point Whitshed-Cape Yakataga area, Alaska, indicates that the most suitable location for a harbor to be excavated by nuclear-device techniques is a section of coastline from Point Martin to the town of Katalla. Three sites selected in the Point Martin-Katalla area are indicated. Site 1 at Point Martin is underlain by terrace gravel overlying sedimentary rocks of Tertiary age. The site is protected from southeast storms but not from southwest storms. Longshore transport of sediments is to the west during high tides and either lacking or to the east during low tides. The 60-foot offshore contour is within 1.5 miles of the site and the 30-foot offshore contour is within 0.4 mile. Site 2 at Palm Point is underlain by beach gravel, terrace gravel, and muskeg deposits that overlie Tertiary sedimentary rocks. The site is protected from southwest storms but exposed to southeast storms, which are the major ones in the Point Whitshed-Cape Yakataga area. The beach at this site is being eroded actively and the sediments are carried offshore by waves that break at right angles to the beach. The 60-foot offshore contour lies within 2 miles of the site area; the 30-foot offshore contour is within 0.3 mile. Site 3 at the town of Katalla is underlain by beach and terrace deposits overlying Tertiary sedimentary rocks. This site offers better protection than either of the other two from southeast and southwest storms. Longshore transport along a spit east of the site has filled the Katalla River channel to within 3 feet of the surface to mean low tide. Dredging requirements at this site would be much greater than at sites 1 and 2. The 60-foot offshore contour is within 3.5 miles of Katalla and the 30-foot contour within 1 mile. (auth)

**12774** TID-5735

Columbia Univ., Palisades, N. Y. Lamont Geological Observatory.

NATURAL RADIOCARBON IN THE ATLANTIC OCEAN. Wallace S. Broecker, Robert Gerard, Maurice Ewing, and Bruce C. Heezen. Mar. 1960. 73p. Contract AT(30-1)-1808. (CU-7-60-AT-(30-1)-1808-Geol.). OTS.

By the use of suitable chemical and radiochemical tech-



niques the natural radiocarbon concentration in the dissolved bicarbonate of 133 samples representing the major water masses of the Atlantic Ocean was determined with a precision ranging from 0.5 to 1.3%. Measurable differences exist between the major water masses, the total range in  $C^{14}/C^{12}$  ratio being about 10%. The surface water results show a progressive increase from south to north, ranging from 120 per mil lower than the atmospheric value in the Antarctic to 49 per mil lower in the North Atlantic. Deep water masses originating in the high latitudes of the Southern Hemisphere have consistently lower  $C^{14}/C^{12}$  ratios than those originating in the high latitudes of the Northern Hemisphere. A layer of high  $C^{14}/C^{12}$  ratio water found between 1200 and 2400 meters depth in the Western North Atlantic may well represent a wedge of young water penetrating the older North Atlantic deep water. A circulation model explaining the prominent features of the  $C^{14}$  distributions in the atmosphere-ocean system was developed. (W.L.H.)

### 12775

PRECISION OF THE DATING METHOD. STANDARDIZATION OF THE CALCULATION OF THE ERRORS AND OF THE MAXIMUM AGE IN THE  $^{14}C$  METHOD. E. H.

Crevecoeur, A. Vander Stricht, and P. C. Capron (Univ. of Louvain, Belgium). *Bull. classe sci., Acad. roy. Belg.* (5), 45, 876-90(1959). (In English)

Because of the wide variation in recording the precision of the carbon dating results, it seems necessary to standardize the method of calculating. The relative importance of several factors, as background radiation, counting time and activity has been analyzed concerning the value of the maximum age, and the precision of the measurements. (auth)

### 12776

REVIEW OF THE ANALYTICAL TECHNIQUES USED IN THE HYDROGEOCHEMICAL PROSPECTION OF URANIUM. A. Grimbart and P. Berthollet (Commissariat à l'Énergie Atomique, Paris). *Chronique mines outre-mer et recherche minière* 27, 43-9(1959). (In French)

The methods recommended for the estimation of uranium in water are surveyed. The advantages and disadvantages of these methods are studied with respect to the qualities necessary for the hydrogeochemical prospection of uranium: sensitivity of the order of  $1/5$  ppb with an accuracy of 15 to 20 per cent, high fidelity, rapidity, simplicity, and low cost. (auth)

### 12777

ABSOLUTE AGE OF A BRANNERITE OF BOU-AZZER (SOUTH MOROCCO). Dolly Ledent (Université, Brussels). *Compt. rend.* 250, 1309-11(1960) Feb. 15. (In French)

The absolute age of a brannerite of Bou-Azzer was determined by the lead method. The most probable age is  $240 \pm 10$  MA, which is placed in the Permian. (tr-auth)

### 12778

NEW METHOD FOR SAMPLING SOLID PARTICLES IN THE STRATOSPHERE. René Challande and Benjamin David (Centre National de la Recherche Scientifique, [Paris] and Commissariat à l'Énergie Atomique, Saclay, France). *Compt. rend.* 250, 1520-1(1960) Feb. 22. (In French)

A method is described which permits the simultaneous collection of microscopic and submicroscopic particles by utilizing the properties of the ionized electric field in the conditions imposed by the rarefied air. An apparatus based on this principle has operated according to prediction up to 15,000 m. (tr-auth)

### 12779

THE SHORT-PERIOD SEISMIC SIGNALS OBTAINED DURING THE REGGANE NUCLEAR TEST, FEBRUARY 13, 1960. Yves Rocard. *Compt. rend.* 250, 2041-2(1960) Mar. 14. (In French)

During the nuclear explosion of February 13, 1960, near Reggane, the short-period seismic signals appear definitely weaker at a distance of 2350 km than one would have thought from the American results obtained during the Nevada tests. The signals appear very strong at 686 km. (tr-auth)

### 12780

THE SEISMIC SIGNALS WITH LONG PERIOD OBTAINED DURING THE REGGANE NUCLEAR TEST ON FEBRUARY 13, 1960. Yves Rocard. *Compt. rend.* 250, 2244-6 (1960) Mar. 21. (In French)

The nuclear explosion of February 13, 1960, near Reggane has furnished at El Goléa a seismic wave of the Rayleigh surface type shaped according to the theoretical predictions for a pulse excitation. At Tamanrasset, on granite terrain, only a vertical component was observed. (tr-auth)

### 12781

DETERMINATION OF URANIUM EQUILIBRIUM IN ROCKS USING  $\alpha$  AND FISSION FRAGMENT RADIOGRAPHY. J. D. Grace and T. F. Bates (Carter Oil Co., Riverton, Wyo. and Pennsylvania State Univ., University Park). *Geochim. et Cosmochim. Acta* 17, 226-33(1959).

A technique for the determination of uranium-daughter product equilibrium in polished sections of rocks by combining  $\alpha$  and fission fragment radiography was developed. The procedure consists of placing an uncovered rock section in contact with, first, an  $\alpha$ -sensitive emulsion to record the  $\alpha$ -particle emission from uranium and its eight  $\alpha$ -emitting daughter products, and second, an emulsion sensitive to fission fragments (but not  $\alpha$ -particles) to record the tracks of fission fragments produced from  $U^{235}$  when the slide is bombarded with thermal neutrons. A sample with approximately 100 ppm of uranium in equilibrium emits about 570  $\alpha$ -tracks/cm<sup>2</sup> per day in an autoradiograph, and about 10,000 fission fragment tracks/cm<sup>2</sup> per hr, when exposed to a neutron flux of  $2.25 \times 10^{10}$  neutrons/cm<sup>2</sup> per sec. A sample deficient in uranium daughter products will release relatively more fission fragment tracks than  $\alpha$ -tracks, and the opposite is true if the sample has a deficiency of uranium with respect to daughter products. The technique is non-destructive, applicable on a micro scale, and suitable for use on samples having uranium contents as low as 10 ppm. (auth)

### 12782

EXPLORATION FOR DEPOSITS OF NUCLEAR POWER MATERIALS. Yu. V. Sharkov. *Priroda* 48, No. 12, 13-21 (1959) Dec. (In Russian)

A review is given of various methods of prospecting and exploration for radioactive mineral deposits. (R.V.J.)

## HEALTH AND SAFETY INCLUDING DOSIMETRY

### 12783

A/AC/82/G/L.315  
New Zealand. Dominion Physical Lab., Lower Hutt.  
NOTES ON MEASUREMENTS OF  $\alpha$ -PARTICLE ACTIVITY OF SOILS, FERTILIZERS, PLANTS AND ANIMALS.  
E. Marsden. Jan. 12, 1960. 5p.

A method is described for determining total alpha activity

of a sample and at the same time determining the relative contributions of the uranium-radium and thorium families. Results are reported from applications of the method in measurements of natural alpha radioactivity of samples of soils, fertilizers, plants, and animal materials. (C.H.)

**12784** AEET/AM/11

India. Atomic Energy Establishment, Trombay. MEASUREMENTS ON THE GROUND DEPOSITION OF FISSION PRODUCTS FROM NUCLEAR TEST EXPLOSIONS. K. G. Vohra, C. Rangarajan, and M. C. Jain. Nov. 30, 1959. 10p.

The deposition levels of mixed fission products at sampling stations throughout India are summarized for the period 1956 through 1959. The cumulative deposition of strontium-90 was computed from the mixed fission product data using empirical relations. The average daily levels of fall-out deposition are related to precipitation levels for the corresponding time. (C.H.)

**12785** AEET/AM/12

India. Atomic Energy Establishment, Trombay. AIRBORNE FALLOUT MEASUREMENTS IN INDIA. K. G. Vohra, C. Rangarajan, and N. A. Ingle. Nov. 30, 1959. 12p.

Studies on the radioactive contamination of the surface air by fall-out from the testing of nuclear weapons have been carried out in India since early in 1956. Data are summarized through 1959. (C.H.)

**12786** AEET/AM/13

India. Atomic Energy Establishment, Trombay. MEASUREMENTS OF CESIUM-137 IN INDIAN AND FOREIGN MILK. K. G. Vohra, V. S. Bhatnagar, U. C. Mishra, and S. Ragupathy. Nov. 21, 1959. 12p.

Data are presented on levels of potassium-40 and cesium-137 in samples of milk collected in India in 1958 and 1959. Results are compared with results from the analysis of samples of foreign milk powder. (C.H.)

**12787** HASL-84

New York Operations Office. Health and Safety Lab., AEC. FALLOUT PROGRAM QUARTERLY SUMMARY REPORT [FOR] DECEMBER 1, 1959 THROUGH MARCH 1, 1960. Edward P. Hardy, Jr. and Stanley Klein. Apr. 1, 1960. 188p. OTS.

Current information coming from the HASL Fall-out Program is summarized along with some information from other programs and laboratories. Data are reported for the period December 1, 1959 to March 1, 1960, on radioactivity levels in deposited fall-out, and in air, water, milk, bread, wheat and its milling products, other foods, and in human bone. Brief interpretive reports on the vertical penetration of strontium-90 in soil and on fall-out deposition are included. Data obtained from the Federal Republic of Germany are included. A bibliography of recent literature is appended. (C.H.)

**12788** HW-20866

Hanford Works, Richland, Wash. HEALTH INSTRUMENT DIVISIONS QUARTERLY PROGRESS REPORT [ON] RESEARCH AND DEVELOPMENT ACTIVITIES [FOR] JANUARY-MARCH 1951. H. M. Parker. Apr. 18, 1951. Decl. Mar. 2, 1960. 30p. Contract W-31-109-Eng-52. OTS.

**12789** HW-25008

Hanford Works, Richland, Wash. RADIOLOGICAL SCIENCES DEPARTMENT QUARTERLY PROGRESS REPORT [ON] RESEARCH AND DEVELOPMENT ACTIVITIES [FOR] APRIL-JUNE 1952. H. M.

Parker. July 11, 1952. Decl. Mar. 2, 1960. 27p. Contract W-31-109-Eng-52. OTS.

**12790** HW-29519

General Electric Co. Hanford Atomic Products Operation, Richland, Wash. RADIOLOGICAL SCIENCES DEPARTMENT QUARTERLY PROGRESS REPORT [ON] RESEARCH AND DEVELOPMENT ACTIVITIES [FOR] JULY-SEPTEMBER 1953. H. M. Parker. Oct. 2, 1953. Decl. Mar. 2, 1960. 35p. Contract W-31-109-Eng-52. OTS.

**12791** HW-32406

General Electric Co. Hanford Atomic Products Operation, Richland, Wash. RADIOLOGICAL SCIENCES DEPARTMENT QUARTERLY PROGRESS REPORT [ON] RESEARCH AND DEVELOPMENT ACTIVITIES [FOR] APRIL-JUNE 1954. H. M. Parker. July 10, 1954. Decl. Mar. 2, 1960. 29p. Contract W-31-109-Eng-52. OTS.

**12792** HW-33437

General Electric Co. Hanford Atomic Products Operation, Richland, Wash. RADIOLOGICAL SCIENCES DEPARTMENT QUARTERLY PROGRESS REPORT [ON] RESEARCH AND DEVELOPMENT ACTIVITIES [FOR] JULY-SEPTEMBER 1954. H. M. Parker. Oct. 10, 1954. Decl. Mar. 2, 1960. 27p. Contract W-31-109-Eng-52. OTS.

**12793** HW-33896(Del.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash. RADIOACTIVE CONTAMINATION IN THE HANFORD ENVIRONS FOR THE PERIOD APRIL, MAY, JUNE 1954. H. J. Paas and G. E. Pilcher. Nov. 24, 1954. Decl. with deletions Dec. 14, 1959. 55p. Contract W-31-109-Eng-52. OTS.

**12794** HW-43370(Del.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash. FEASIBILITY OF IN VIVO PLUTONIUM MEASUREMENTS. W. C. Roesch and J. W. Baum. May 14, 1956. Decl. with deletions Jan. 24, 1958. 7p. Contract W-31-109-Eng-52. OTS.

Experiments were performed with available equipment to estimate the performance of the proposed body monitor in detecting microcurie amounts of plutonium. It was shown that the detectors proposed for the body monitor would detect 0.02 microcurie of plutonium in the chest cavity. (C.H.)

**12795** NAA-SR-Memo-4822

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif. CLOUD-AN IBM 709 PROGRAM FOR COMPUTING GAMMA-RAY DOSE RATE FROM A RADIOACTIVE CLOUD. D. S. Duncan. [1959]. 93p. OTS.

CLOUD is an IBM 709 code which calculates the external gamma-ray dose rate and total integrated dose resulting from the continuous release of radioactive materials to the atmosphere. The code was programmed in FORTRAN II for a 32 K machine. Meteorological parameters such as wind velocity, lateral and vertical diffusion coefficients, stability parameters and the presence of physical boundaries such as a ground surface and a temperature inversion layer are considered. Depletion of the cloud due to wash-out and fall-out has also been included. A two compartment continuous release model is assumed. Decay of the source material is described either by the use of a simple parent-daughter de-



cay scheme or by a Way-Wigner type relationship. The analytical expressions used in the analysis are developed and the programming techniques are described. A sample problem and a FORTRAN listing of the source deck are included. (auth)

**12796** NP-8524

Naval Civil Engineering Lab., Port Hueneme, Calif.  
ABC DECONTAMINATION EQUIPMENT FOR PERSONNEL IN THE ARCTIC. Final Report. (Technical Report R-072). W. R. Nehlsen. Mar. 8, 1960. 19p.

A 60 man per hour portable shower unit was designed to fulfill requirement for decontamination of large numbers of personnel in arctic climates. A shower waste water treatment and recirculation system was included to minimize the effects of critical water shortages expected under arctic conditions. Tests performed on the shower waste recirculation system showed that satisfactory results could be obtained on atomic and biological agents, but the allowable time interval before starting chemical agent decontamination proved to be so brief that no mass decontamination method could be considered effective. Because of the inherent dangers of the recirculating system, an individual washing kit was devised as an alternative to the shower unit. The individual washing kit is safer and more economical for atomic and biological decontamination, but neither system is suitable for chemical agent decontamination. (auth)

**12797** NP-8572

Naval School of Aviation Medicine, Pensacola, Fla.  
TISSUE DEPTH DOSES IN THE HIGH INTENSITY PROTON RADIATION FIELD OF THE INNER VAN ALLEN BELT. Report No. 16. Hermann J. Schaefer. Nov. 10, 1959. 14p. Research Project MR005.13-1002.

The energy spectrum of the proton radiation field in the inner Van Allen Belt at 1230 kilometers altitude has been established by Freden and White on the basis of nuclear emulsion recordings. These data are evaluated in terms of tissue depth doses for a human target. The extreme heterogeneity of the radiation is demonstrated by deriving the differential range spectrum and by investigating the effect of prefiltration. For a spherical tissue target of 52 cm diameter (75 kg) behind a shield of 2 g/cm<sup>2</sup> an entrance dose rate of 0.23 rep/hour and a depth dose in the center of 0.10 rep/hour are found. Extrapolation to the center of the inner belt at 3000 km leads to an entrance dose of 130 rep/hour. (auth)

**12798** RIGO-1959/2

Netherlands. Gezondheidsorganisatie, TNO. Radiobiologisch Instituut, Rijswijk and Netherlands. Rijksverdedigingsorganisatie, TNO. Medisch Biologisch Laboratorium, Rijswijk.

RADIOACTIVE STRONTIUM IN SOIL, CROPS, FOOD-STUFFS AND HUMAN BONES IN THE NETHERLANDS. PART 2. G. W. Barendsen, T. L. J. Beusker, J. F. Bleichrodt, and T. H. L. van Beukering. Dec. 1959. 20p. (MBL-1959/5)

Results are presented for 1958 and 1959 on Sr<sup>89</sup> and Sr<sup>90</sup> analyses on various biological materials. First Sr<sup>89</sup> and Sr<sup>90</sup> concentrations are given of soil, grass, and milk obtained from different localities, selected for high and respectively low calcium contents of the soils. Comparison with the results of 1957 shows a relatively small increase of Sr<sup>90</sup> in the soil, about 10%, but much larger increases up to 150% of Sr<sup>90</sup> concentrations per gram of calcium in milk. The December 1957 milk data reflect levels present in winter fodder while the May 1958 data reflect levels occurring in the pastures. Samples of grass taken in May 1958

contained less Sr<sup>90</sup> per gram of calcium than grass taken in December 1957. (auth)

**12799** TID-3551

Technical Information Service Extension, AEC.  
RADIATION PROTECTION STANDARDS. A Literature Search. William E. Bost, comp. Apr. 1960. 30p. OTS.

Included are 296 references to reports and published literature written since 1957 on radiation protection standards. Recommendations of the National and International Commissions on Radiological Protection are covered along with papers on criteria and philosophy leading to the establishment of these recommendations. Peripheral information is contained in references reflecting current practices in atomic energy operations and in diagnostic and therapeutic radiology. (auth)

**12800** TID-5662

Idaho Operations Office. Health and Safety Div., AEC.  
IMPROVEMENTS IN PERSONNEL METERING PROCEDURES AT NRTS. F. V. Clipperley and W. P. Gammill. [1959] 16p. OTS.

Paper presented at the Health Physics Society Meeting, June 19, 1959, Gatlinburg, Tennessee.

A brief history, equipment, and procedures used by the Personnel Metering Branch of the Health and Safety Division of the Idaho Operations Office at the NRTS are presented. (W.L.H.)

**12801** TID-5710

Isotopes, Inc., Westwood, N. J.  
STUDIES OF NUCLEAR DEBRIS IN PRECIPITATION. Quarterly Progress Report No. 3. Mar. 15, 1960. 64p. Contract AT(30-1)-2415. OTS.

A new precipitation collector 10 feet in diameter is described. It was noticed that there were some discrepancies between the assays of total beta, Sr<sup>89</sup>, Sr<sup>90</sup>, and W<sup>185</sup> in the high-walled stainless steel monthly pot samples and in the individual rains when summed over a given monthly period. An extra sampling device, consisting of a plastic funnel which drains into an ion exchange column, was installed alongside the other samplers and the data from the three are compared. The variability of radioactivity in precipitation is discussed in terms of measurement errors, the total variability, the seasonal variation, total fall-out and total precipitation, specific activity in fall-out and total precipitation, specific activity and rainfall intensity, specific activity in snow and rain, and concentration of radioactivity in air. The mechanism of dry fall-out removal from the troposphere by gravitational settling or impaction on vertical and quasi-vertical surfaces is discussed in some detail. (W.D.M.)

**12802** TID-8206

Office of Health and Safety, AEC.  
A COMPENDIUM OF INFORMATION FOR USE IN CONTROLLING RADIATION EMERGENCIES, INCLUDING LECTURE NOTES FROM A TRAINING SESSION AT IDAHO FALLS, IDAHO, FEBRUARY 12-14, 1958. Allen Brodsky and G. Victor Beard, Comps. and Eds. Feb. 1960. 102p. OTS.

Information is summarized which may be needed by trained personnel in exercising rapid and professional judgment during the period immediately following an unexpected radiological incident. Past experiences in radiation accidents are reviewed. The shipment of radioactive materials and the control of fires during radiation emergencies are discussed. The results of fuel element burn tests are reviewed and monitoring activities are described. (C.H.)

**12803** USNRDL-TR-396

Naval Radiological Defense Lab., San Francisco.  
SOIL ANALYSIS BY NEUTRON ACTIVATION. F. M.  
Tomnovec. Jan. 28, 1960. 11p.

The use of the neutron activation method of soil analysis is discussed. Data are presented which show the results of the analysis on various soils. The analysis indicates a large variation in chemical content can occur in adjacent areas. Where interest exists only in the gamma-ray emitting elements produced when the soil is exposed to neutrons, this method is a rapid and inexpensive means of soil analysis. (auth)

**12804** AEC-tr-4023

THE SEPARATION OF RADIOACTIVE AEROSOLS BY FIBROUS FILTERS. W. Zumach. Translated for Los Alamos Scientific Lab. from *Atompraxis* **3**, 377-82 (1957). 12p. JCL.

A review of the chemical and physical characteristics of aerosols is presented and basic information concerning their separation is given. Filter efficiencies are also discussed. (J.R.D.)

**12805** IGIS-74(RD/R)

AIR FILTERS FOR THE SEPARATION OF RADIOACTIVE DUST. F. H. Becker. Translated by E. J. Garvin (U.K.A.E.A. Risley) from *Chem.-Ingr.-Tech.* **31**, 145-8 (1959). 10p.

Exhaust air from installations which emit radioactive dust must be cleaned with the greatest care. Regulations governing the testing of air filters for these purposes refer to test dusts with particle diameters in the size orders of  $0.1 \mu$ . This is necessitated by the reject mechanism of the filters which are technically usable. Filter installations for the collection of radioactive dusts are illustrated. (auth)

**12806**

THE PRE-OPERATIONAL ENVIRONMENTAL SURVEY FOR THE ENRICO FERMI REACTOR—1958. John V. Nehemias and G. Hoyt Whipple (Univ. of Michigan, Ann Arbor). *Am. Ind. Hyg. Assoc. J.* **21**, 144-50 (1960) Apr.

Methods and results are summarized from a pre-operational environmental survey for the Enrico Fermi Reactor. The data will provide a basis for comparison with levels of environmental radioactivity observed after the reactor is in operation. (C.H.)

**12807**

CONTAMINATION RESULTING FROM THE RELEASE OF RADIOACTIVE LIQUID WASTES TO THE TENNESSEE RIVER SYSTEM. H. H. Abee and W. D. Cottrell (Oak Ridge National Lab., Tenn.). *Am. Ind. Hyg. Assoc. J.* **21**, 156-61 (1960) Apr.

The high-volume, low-level radioactive liquid wastes originating at Oak Ridge National Laboratory are dispersed into the Tennessee River System by way of White Oak Creek and the Clinch River. Releases are controlled so that the resulting average concentration in the Clinch River complies with permissible levels set forth by the National Committee on Radiation Protection and the International Commission on Radiological Protection. Since 1951 measurements have been made of the radioactivity in the water and of the accumulation of radioactivity on the bottom sediment of the Clinch and Tennessee Rivers. Findings of the surveys on radioactivity on the bottom sediment are summarized for 1954 through 1958. (C.H.)

**12808**

RADIATION DOSAGE TO MEDICAL PERSONNEL. Russell F. Cowing (New England Deaconess Hospital, Boston). *Am. Ind. Hyg. Assoc. J.* **21**, 169-72 (1960) Apr.

A survey was made to evaluate exposure to those physicians and dentists employing radiation. Many medical personnel other than radiologists employ radiation such as the general practitioner, surgeon, urologist, and the dentist. It is emphasized that among the various specialty groups varied factors of kilovoltage, current filter, technique, etc., will result in completely different values of exposure both to the patient and worker. In the National Bureau of Standards Handbook X-ray Protection, recommendations as to total filter in the diagnostic x-ray beam are made. The 2.5 mm of aluminum recommended in medical-diagnostic units greatly reduces the exposure to patients and personnel. The use of lead-rubber aprons during fluoroscopy is also recommended. This paper presents figures on protection afforded by such aprons. Other specialists can reduce their exposure considerably by keeping their hands out of the primary beam. Dentists sometimes hold film in place. By avoiding this procedure and by utilizing a total of 1.5 mm of aluminum in the beam, they can reduce exposure to themselves and to the patient. Exposure values are presented for different techniques employed by specialists. A summary of film badge data is presented. (auth)

**12809**

HEALTH ASPECTS OF THE COMMERCIAL MELTING OF URANIUM-CONTAMINATED FERROUS METAL SCRAP. R. H. Starkey, J. W. McKelvey, B. J. Held, and E. L. Alpaugh (National Lead Co. of Ohio, Cincinnati). *Am. Ind. Hyg. Assoc. J.* **21**, 178-81 (1960) Apr.

Large-scale smelting of uranium-contaminated steel can be carried out with no health hazard to the workers involved if relatively simple industrial hygiene controls are exercised. The method and associated industrial hygiene procedures are described. (C.H.)

**12810**

IONIZING RADIATION AND RADIOACTIVITY—DANGERS AND PRECAUTIONS. H. Wijker. *Electrotechniek* **37**, 54-9 (1959). (In Dutch)

The principles of ionizing radiations are discussed. Special attention is given to such topics as units, dosimetry, hazards, and waste disposal. (Reactor Centrum Nederland)

**12811**

DETERMINATION OF RADIOACTIVE FALLOUT FROM NUCLEAR WEAPON TESTS. I. GAMMA-RAY SPECTROMETRIC DETERMINATION OF SMALL AMOUNTS OF  $^{95}\text{Zr}$ — $^{95}\text{Nb}$  ADSORBED ON PINE LEAVES. K. Ueno (Japan Atomic Energy Research Inst., Tokyo). *J. Atomic Energy Soc. Japan* **2**, 67-72 (1960) Feb. (In Japanese)

The gamma-ray spectra of pine leaves collected in 1958 and 1959 show two remarkable peaks. The 0.13 Mev peak is actually a combination of peaks of  $\text{Ce}^{141}$  and  $\text{Ce}^{144}$ — $\text{Pr}^{144}$ , while the 0.76 Mev peak is assigned to  $\text{Zr}^{95}$ — $\text{Nb}^{95}$ . The decay curves of the gamma activity at 0.76 Mev correspond to curves of  $\text{Zr}^{95}$ — $\text{Nb}^{95}$  with half-life of 65 days. One gram of pine leaf ash contains 2 to 6  $\mu\text{mc}$   $\text{Zr}^{95}$ — $\text{Nb}^{95}$ . (auth)

**12812**

DECONTAMINATION REACTIONS OF SYNTHESIZED FALLOUT DEBRIS FOR NUCLEAR DETONATIONS. I. NUCLEAR DETONATION IN SEA WATER. Carl F. Miller, Richard Cole, and Warren J. Heiman (U. S. Naval Radiological Defense Lab., San Francisco). *J. Colloid Sci.* **13**, 337-47 (1958) Aug.

The expected general composition of fall-out from a nuclear detonation in a homogeneous liquid medium (sea



water) is discussed. Simplified contaminants each containing a single fission product element and sea water applied to a painted surface were decontaminated by water washing. Decontamination as a function of initial level or surface density of most of the FP elements used was found to follow the modified Freundlich relationship  $R = aI^n$  in which  $I$  is the initial level,  $R$  is the level remaining after decontamination, and  $a$  and  $n$  are constants for each element. (auth)

**12813**

DECONTAMINATION REACTIONS OF SYNTHESIZED FALLOUT DEBRIS FOR NUCLEAR DETONATIONS. II. LAND-SURFACE NUCLEAR DETONATION. Carl F. Miller, Richard Cole, W. B. Lane, and J. L. Mackin (U. S. Naval Radiological Defense Lab., San Francisco). J. Colloid. Sci. **13**, 348-57(1958) Aug.

The decontamination of San Francisco harbor bottom soil, Nevada test site soil, and a commercial clay from a paint surface was done with stirred and sprayed water. The surface density of soil remaining after decontamination was found to depend on the initial condition according to the equation,  $R_m = R_{M_0}(1 - e^{-ay})$  in which  $R_{M_0}$  is a constant related to the mean particle size remaining,  $a$  is a constant related to the mean particle size and density of the deposited soil, and  $y$  is the surface density of the initial deposit. Estimates are made for the gamma radiation intensity over the contaminated and decontaminated surfaces for the case in which the surface area is large and the soil is fallout from a surface land atomic detonation. (auth)

**12814**

LABOR CONDITIONS OF THE PERSONNEL DURING WORK WITH CLOSED RADIOACTIVE SOURCES IN MEDICAL INSTITUTIONS. T. S. Seletskaya and I. E. Pasykova. Med. Radiol. **5**, No. 2, 66-72(1960) Feb. (In Russian)

The doses to which personnel are subject when working with closed radioactive substances were investigated. Methods of reducing the dose rate are discussed. (C.J.G.)

**12815**

STRONTIUM-90 IN THE 'MIXED LAYER' OF THE ATLANTIC OCEAN. Vaughan T. Bowen (Woods Hole Oceanographic Institution, Mass.) and Thomas T. Sugihara (Clark Univ., Worcester, Mass.). Nature **186**, 71-2(1960) Apr. 2.

An analysis of the distribution of  $Sr^{90}$  from nuclear bomb fall-out in the Atlantic Ocean, both north and south of the equator, was made. The water columns sampled appeared to have three or four times as much total  $Sr^{90}$  below 100 m as remained above that depth. A direct vertical movement by wind-driven mixing was indicated. (C.J.G.)

**12816**

AUTOMATIC FILM-BADGE READER. Mack Wilhelmsen, DeRay Parker, Robert W. Coulter, and Paul R. Boren (Atomic Energy Commission, Idaho Falls, Idaho). Nucleonics **18**, 84; 86; 88(1960) Apr.

A description is given of the method used to process several thousand film badges per week at the National Reactor Testing Station. It is a highly automated film-reading and data-recording system. The film reader consists of a densitometer head, a badge-number matrix, a film-density computer, two digital voltmeters (one for beta dose and one for gamma), a master control panel, and associated power supplies. Pertinent information, collected by the film reader, is fed to a modified Model 026 IBM card punch which produces a permanent punched record. The processing method is given chronologically from the time the badge is deposited by the exposed personnel at the end of the exposure period until it is redeposited by monitoring

personnel for pickup by the workmen at the start of the new exposure period. Performance studies have shown that the reader is linear and has a reproducibility of about 97%. The cost for duplication of this system is estimated to be about \$10,000. (B.O.G.)

**12817**

PROTECTION CONTRE LES RADIATIONS IONISANTES. (Protection Against Ionizing Radiations). New York, Pergamon Press, 1958. 444p. \$6.00.

The series of lectures given during a course in protection against ionizing radiations is presented. The lectures are divided into several sections. The first part serves as an introduction in which the elementary principles of nuclear physics are discussed. The second part concerns radiobiology, and the effect of radiation on cells, tissues, and the entire organism, and the genetic and somatic effects are described. Then protection against these radiations is considered. The national and international aspects of the problem of protection are discussed in a final chapter. (J.S.R.)

**12818**

PROTECTION AGAINST RADIATIONS. Aristides Pinto Coelho (Sociedade Brasileira de Medicina Física). Fóton **1**, No. 4, 26-31(1959) Mar. (In Portuguese)

The internal and external effects of radiation and the factors affecting them are briefly discussed. The measurement of the dose received is considered, and a definition of the dose units is given. (J.S.R.)

**12819**

RADIATION CONTROL, FOR FIRE AND OTHER EMERGENCY FORCES. Andrew A. Keil. Boston, National Fire Protection Association, 1960. 249p.

Radioactive materials are usually present in such extremely small quantities as to present no real fire or explosion hazard even when their chemical nature is such that they do burn or explode. Nevertheless, when involved in fires or other emergencies, they may become a serious health hazard to the general public as well as to the fire-fighting forces. It is imperative that fire department officials know, before the fire or emergency occurs, exactly where radioactive materials are stored, handled, or used within the boundaries of their areas of responsibility. Descriptions are included of actual situations involving radioactivity which have been faced by fire and emergency forces. Procedures for the safe handling of radioactive materials are reviewed. (C.H.)

**ISOTOPE SEPARATION****12820 JPRS-2455**

THE SEPARATION OF STABLE ISOTOPES OF CARBON BY THE COUNTER FLOW CHEMICAL EXCHANGE METHOD IN THE GASEOUS PHASE. [PART] I. G. M. Panchenkov, I. A. Semiokhin, A. G. Maurina, and N. P. Yershova. Translated from Zhur. Fiz. Khim. **30**, 2070-6 (1956). 13p. OTS.

The process of separation of the isotopes of carbon was studied in a thermal diffusion column using the counter flow chemical exchange method. The optimum pressure of carbon dioxide for the separation was found to be 500 mm Hg. An increased effect in separation was obtained by using steam. The introduction of hydrogen into the system increased the effectiveness of the separation initially, but with increased hydrogen concentration the efficiency was decreased. (C.J.G.)

**12821 JPRS-2458**

THE CONCENTRATION OF A HEAVY ISOTOPE OF NITROGEN BY THERMAL DIFFUSION. B. A. Geller. Translated from *Zhur. Fiz. Khim.* 30, 1871-6(1956). 12p. OTS.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 12, as abstract No. 9298.

**12822 JPRS-2459**

THE CALCULATION OF CASCADES USED IN SEPARATING STABLE ISOTOPES. V. K. Turkin. Translated from *Nauch. Doklady Vyssheĭ Shkoly, Khim. i Khim. Tekhnol.* No. 2, 385-7(1958). 6p. OTS.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 23142.

**12823**

SEPARATION OF HYDROGEN, HYDROGEN DEUTERIDE, AND DEUTERIUM BY GAS CHROMATOGRAPHY. Hilton A. Smith and Paul P. Hunt (Univ. of Tennessee, Knoxville). *J. Phys. Chem.* 64, 383-4(1960) Mar.

Quantitative separation of hydrogen, hydrogen deuteride, and deuterium was accomplished with a chromia-alumina column at 77°K and with neon as carrier gas. Analysis of a known mixture gave a standard deviation of 0.5 to 1.0%. Partial deactivation of the column with water improved the symmetry of the peaks. (D.L.C.)

**12824**

URANIUM ISOTOPE SEPARATION BY NOZZLES. Myron Levoy (Thiokol Chem. Corp., Denville, N. J.). *Nucleonics* 18, No. 4, 68-70, 118(1960) Apr.

The concepts of a method for the enrichment of uranium in  $UF_6$  which makes use of nozzles are presented. This method is considered capable of competing alternatively with the gaseous diffusion method. Experiments with  $UF_6$  have shown that the separation effect per stage is the same order of magnitude as in the conventional process. Process and nozzle parameters are given relative to pressure diffusion created by radial pressure gradients in the jet. The basic theory concerning nozzle separation process is discussed. (B.O.G.)

**12825**

METHOD OF ISOTOPE CONCENTRATION. Thomas Ivan Taylor and William Spindel. British Patent 830,937. Mar. 23, 1960.

A  $N^{15}$  enrichment process is described based on exchange between NO and  $HNO_3$ . The liquid  $HNO_3$  enriched in  $N^{15}$  by the countercurrent exchange is reduced by  $SO_2$  to NO enriched in  $N^{15}$ . (T.R.H.)

## MATHEMATICS AND COMPUTERS

**12826 CF-60-3-48**

Oak Ridge National Lab., Tenn.  
IBM 704 GAUSSIAN-INTEGRATION ROUTINES. M. P. Lietzke. Mar. 14, 1960. 12p. OTS.

Three Gaussian-integration routines were written for the IBM 704 and placed on the FORTRAN Library tape. These routines may be used singly or in combination to perform single, double, or triple integration of any function within a FORTRAN program. Either fixed or variable integration limits may be used. (auth)

**12827 CF-60-4-78**

Oak Ridge National Lab., Tenn.  
AN IBM 704 SUBROUTINE FOR TRAPEZOIDAL INTEGRATION WITH CONTROLLER ERROR (TRICE). C. S. Nestor. Apr. 19, 1960. 7p. OTS.

A description of the IBM-704 subroutine TRICE, which evaluates a single integral by means of the trapezoidal rule approximation is given. In the calculational procedure, the integration step is halved until the desired degree of convergence is reached or until a preset maximum number of steps is exceeded. A maximum of ten different integrands may be used in any one calling program. The subroutine is written in FORTRAN. (auth)

**12828 IDO-14508**

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

MEASUREMENT ERROR—IDENTIFICATION AND ESTIMATION. F. H. Tingey. Mar. 9, 1960. 19p. Contract AT(10-1)-205. OTS.

The concept of component error estimation in any given measurement method is discussed. Rules are given for the construction of the mathematical model assumed for the data. The arithmetic detail of computation, the expectation under the model for the quantities computed, and the solution of the resulting system of equations for the component variations are described. Examples in the field of nuclear fuel processing are given to demonstrate the methods. (C.J.G.)

**12829 SCR-158**

Sandia Corp., Albuquerque, N. Mex.  
LOGARITHMS OF FACTORIALS FROM 1 TO 2000. D. B. Owen and C. M. Williams. Dec. 1959. 34p. OTS.

A table of logarithms, to the base 10, of factorial  $n$  is given for values of  $n = 1(1)2000$  to 15 decimal places. (auth)

**12830 TID-5739**

Illinois. Univ., Urbana. Digital Computer Lab.  
SEPARATE CARRY STORAGE ADDERS. Report No. 97. S. Takahashi. Mar. 7, 1960. 13p. Contract AT(11-1)-45. OTS.

A discussion is presented of the base 4 adder which will be the heart of the arithmetic unit of the New Illinois Computer. (J.R.D.)

## METALS, CERAMICS, AND MATERIALS

### General and Miscellaneous

**12831 BMI-1428**

Battelle Memorial Inst., Columbus, Ohio.  
DEVELOPMENT OF THORIUM-URANIUM-BASE FUEL ALLOYS. Martin S. Farkas, Arthur A. Bauer, and Ronald F. Dickerson. Mar. 18, 1960. 30p. Contract W-7405-eng-92. OTS.

Thorium-uranium alloys were studied with the aim of developing alloys with improved irradiation behavior by control of microstructure. The effect of thorium purity, melting technique, hot and cold working, and heat treatment on microstructure was investigated. The most significant microstructural differences occurred as a result of casting technique. The arc-melted alloys exhibited the most nearly ideal structure, that of a homogeneous dispersion of small-diameter uranium particles in a thorium matrix. In addition, the rate of work hardening, recrystallization behavior, density, and hot hardness of thorium-uranium alloys were determined. As uranium content increases, the rate of work hardening increases. The recrystallization temperature of thorium was found to increase by over 100°C when uranium is present. Molyb-



denum, niobium, zirconium, and zirconium in conjunction with niobium were added to thorium-uranium with the aim of increasing irradiation resistance by stabilizing the gamma-uranium phase and/or improving the high-temperature strength of the alloy. It was found that small additions of molybdenum or niobium were effective in stabilizing the gamma-uranium phase, while zirconium was an effective hardener at temperatures up to 600°C. Zirconium additions to thorium-uranium alloys were effective in improving the 300°C water corrosion resistance of thorium by a factor of two. (auth)

**12832** HW-58311

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

ALTERNATE SIEVE PLATE MATERIALS FOR THE "ZEBRA" CARTRIDGE. W. R. Hamilton and J. H. Kleinpeter. Dec. 22, 1958. 6p. Contract W-31-109-Eng-52. OTS.

Sieve plate materials were evaluated for the "zebra" cartridge. An operationally satisfactory and structurally strong sieve plate was obtained by press polishing a linear polyethylene coated stainless steel plate. These plates produced coalescence equivalent to that of solid linear polyethylene sieve plates. Zones of polyethylene Raschig Rings ( $\frac{5}{8}$ -in.) performed satisfactorily only when the free area of the retaining plates was increased to the point of excess plate flexibility. Oil wet zirconium and oil wet oxidized stainless steel performed very well but were found to lose their coalescing power under normal column clean-up procedures. (C.J.G.)

**12833** HW-62701

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

THE IRRADIATED RUPTURE PROTOTYPE (IRP) DESIGN. G. E. Neibaur and N. D. Stice. Feb. 15, 1960. 12p. Contract AT(45-1)-1350. OTS.

The design and description of the Irradiated Rupture Prototype (IRP), a loop for decontamination studies and evaluating rupture characteristics of irradiated fuel elements, are given. Drawings are presented for the electrical and flow diagram, the assembly, and the slug rupture cask. (C.J.G.)

**12834** KAPL-M-CTS-1

Knolls Atomic Power Lab., Schenectady, N. Y. AVAILABILITY OF NIOBIUM (COLUMBIUM). C. T. Sims. Mar. 8, 1960. 8p. Contract W-31-109-eng-52. OTS.

A review of the availability status of niobium is presented. The natural occurrence, known reserves, price, and production of niobium are discussed. (C.J.G.)

**12835** LS-64

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON NICKEL ELECTROPLATING OF URANIUM. Aug. 1959. 5p.

A bibliography is presented on the electroplating of U with Ni. The references were taken from Nuclear Science Abstracts Vols. 4-12, 1950-58, and Vol. 9, Nos. 1-10, Chemical Abstracts Vols. 50-52, 1956-58, and Vol. 53, Nos. 1-11, Metallurgical Abstracts Vols. 19-25, Sept. 1951-Aug. 1958, and Vol. 26 up to July 1959, and reports in the Israel Atomic Energy Commission Library. 24 references. (T.R.H.)

**12836** MAB-154-M(1)(Vol. II)

National Research Council. Materials Advisory Board. MATERIALS ADVISORY BOARD REPORT OF THE COMMITTEE ON REFRACTORY METALS. VOLUME II.

PANEL REPORTS. Oct. 15, 1959. 317p. Contract DA-36-039-sc-76436.

Reports are presented in this volume from seven different panels on various refractory metals. The first chapter is devoted to the fabrication of refractory metals by non-conventional methods. In the second chapter the joining of various refractory metals by different methods is reported. Chapter three reports various problems in the analysis of refractory metals. The next seven chapters are reports on chromium, niobium and tantalum, molybdenum, tungsten, vanadium, rhenium, and platinum-group metals, respectively. (W.L.H.)

**12837** NP-8522

Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

INVESTIGATION OF HIGH TEMPERATURE RESISTANT MATERIALS. Quarterly Report No. 16 [for] November 1, 1959 to January 31, 1960. C. R. Mason, J. D. Walton, M. D. Bowen, W. T. Teague, and C. A. Murphy. 66p. Project No. A-212. Contract NOrd-15701.

Thermal Protection Systems. A technique for producing wax molds without machining was developed to be used in casting aluminum heater plates. Several new heater plates were made with this method and Pt-Pt<sub>87</sub>Rh<sub>13</sub> thermocouples were imbedded in the surface. Several flat plate samples of various thicknesses were exposed to the exhaust gases of the oxyhydrogen motor. The thermal conductivity and thermal diffusivity of slip-cast fused silica were determined by backside temperature measurements on samples exposed to the oxyhydrogen motor. The strength of slip-cast fused silica fired for 8 hours was somewhat lower than that which was fired for 17 hours at temperatures ranging from 1700 to 2300°F. Coatings. Machined water- and air-cooled brass patterns; slip-cast fused silica patterns; and machined graphite patterns were used in an effort to reduce the standoff distance of the Plasma gun when forming thin arc-sprayed shapes. Six tensile test specimens were obtained by arc spraying molybdenum disilicide onto the graphite pattern. Efforts at spraying fused silica produced a thin greyish-black coating on fired fused silica plates that resisted color change after being subjected to an oxidizing atmosphere for 8 hours at 1600°F. Thermets. An x-ray analysis was made on the thermet containing 65% beryllium-chromic oxide thermite and 35% of BeO to determine the various components or compounds found in an ignited sample. Investigations were started to determine the properties and effects produced in Be-chromic oxide thermets when BeO and Cr were used as combined throttling material. The results indicated that a variety of thermite-to beryllia-to-chromium ratios may be used to obtain the same final composition. Studies were begun to develop a slip-casting technique to be used with beryllium-chromic oxide thermets. (For preceding period see NP-7842.) (W.L.H.)

**12838** NYO-2571

Aeroprojects, Inc., West Chester, Penna. APPLICATIONS OF ULTRASONIC ENERGY. Progress Report No. 17 covering Period from August 1, 1959 to September 30, 1959. Oct. 1959. 39p. Contract AT(30-1)-1836. OTS.

Studies on ultrasonic coalescence of oil-in-water emulsions were continued in series operated annular treatment vessels. Results are in the range expected from individual operation of the vessels and further geometry modifications are in process. Dissolution of uranium slugs in cadmium at 525°C was carried out in the high-temperature controlled-atmosphere ultrasonic treatment furnace. In

four hours 30 grams of uranium were dissolved in contrast to none in a non-ultrasonic control. The propagation of ultrasonic energy in various ceramic, stainless steel, and cermet powder slips was estimated. Improvement in the fired density of a cermet composition was observed in preliminary experiments. A major improvement in the surface of alumina extrusion specimens was obtained. The finish was smoother and evidence of drag and surface pitting completely eliminated in contrast to the non-ultrasonic control. It was also found that extrusions could be accomplished at 0.2 wt.% plasticizer which were equivalent to those normally requiring over 2 wt.%. Sub-micron aerosols simulating those expected in the Idaho Falls calciner off-gas system were successfully coalesced in a multi-stage apparatus. With the use of a standing wave system and low concentrations of additive aerosol, effluent concentration of 0.5 to 0.75 micrograms per cubic foot were attained. Linear velocities in the range of 33 to 325 feet per minute were examined with satisfactory removal of particulate matter. (For preceding period see NYO-2570.) (auth)

#### 12839 NYO-2686

Olin Mathieson Chemical Corp. Metallurgical Labs., New Haven.

NUCLEAR FUEL RESEARCH, FUEL CYCLE DEVELOPMENT PROGRAM—THE CARBIDES OF URANIUM. AN ANNOTATED BIBLIOGRAPHY. F. E. Bowman, comp. Mar. 2, 1960. 19p. Contract AT-(30-1)-2374. OTS.

This annotated bibliography presents information on the preparation and properties of uranium carbides. (W.L.H.)

#### 12840 ORNL-2217(Del.)

Oak Ridge National Lab., Tenn.

METALLURGY DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING OCTOBER 10, 1956. Decl. with deletions Nov. 4, 1959. 231p. Contract W-7405-eng-26. OTS.

Progress is reported in corrosion studies of stainless steels, Nb, Zr, Al-Fe-Mo, Mo, Ni alloys, and Al-Ni by various materials including Na, Na-K, Li, Rb, and fused salts. Corrosion studies in pump loops of various materials by fused salts and liquid metals are reported. Fuel elements and shielding materials for ART and APPR are being developed. General studies in welding and brazing, nondestructive testing, fabrication, and inspection are described. Developments in high-temperature metals and ceramics, metallographic techniques, ceramic materials, and Zr alloys are reported. (T.R.H.)

#### 12841 ORO-263

Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

MONTHLY LETTER REPORT NO. 16 COVERING THE PERIOD FROM FEBRUARY 15 TO MARCH 15, 1960. J. D. Fleming. Mar. 25, 1960. 2p. Project No. B-153. Contract AT(40-1)-2483. OTS.

Testing of irradiated silica bars was continued. Results of statistical analyses showed that the transverse strength of the irradiated silica samples was lower by about 10% than for nonirradiated specimens. Samples of silica were cast in the configuration for the Armour ring test (see monthly report No. 13). Six such samples fired at 2200°F for 4 hours had an average tensile strength of 3260 psi, while similar samples cast in the configuration of a D had an average tensile strength of 3250 psi. Other investigations are reported on continued efforts to determine the optimum plaster and plaster conditions for silica casting and on determination of the firing temperature for Be- $\text{UO}_2$

thermet mixture. (For preceding period see ORO-255.) (J.R.D.)

#### 12842 ORO-264

Carborundum Co. Research and Development Div., Niagara Falls, N. Y.

SYNTHESIS AND FABRICATION OF REFRACTORY URANIUM COMPOUNDS. Quarterly Report No. 3 [for] December 1, 1959 to February 29, 1960. K. M. Taylor, C. A. Lenie, P. E. Doherty, L. N. Halley, and T. J. Keaty. Mar. 14, 1960. 19p. Contract AT(40-1)-2558. OTS.

Experiments on preparation of uranium mononitride by nitridding uranium metal were conducted which yielded a high-quality product. The nitride powder reduced to particle size of about 1 micron and was cold pressed and sintered to a density of 91 to 93% of theoretical. Uranium monocarbide prepared for alternate use in preparing the mononitride by nitridding a mixture of  $\text{UO}_2$  and carbon was ball milled to about 1 micron and was cold pressed and sintered to a density of 93 to 95% of theoretical. Preparation of  $\text{U}_3\text{Si}_2$  by a non-quench method is reported. Magnesia was found to be the best crucible material for use in this method. Pellets of  $\text{U}_3\text{Si}_2$  prepared by cold pressing and sintering were 93% of theoretical density. This material is pyrophoric. (For preceding period see ORO-248.) (J.R.D.)

#### 12843 WADC-TR-57-344(Pt.IV)

Westinghouse Electric Corp. Aviation Gas Turbine Div., Kansas City, Mo. and Westinghouse Electric Corp. Research Labs., Pittsburgh.

DEVELOPMENT OF NIOBIUM-BASE ALLOYS. Period covered: June 1, 1958 to June 1, 1959. Richard T. Begley and William N. Platte. Jan. 1, 1960. 131p. Project title: METALLIC MATERIALS. Task title: REFRACTORY METALS. Contract AF33(616)-5754.

Vacuum tensile data were obtained for pure niobium at 68 to 2500°F. The data for niobium followed the general pattern exhibited by other pure refractory metals. The ductile-brittle transition (in impact) for commercial purity, arc melted niobium was close to room temperature. The effect of binary additions of Ti, Zr, Hf, V, Mo, W, Re, Al, and Y on the hardness and workability of niobium was determined. Nb-Ti and Nb-Y alloys exhibited excellent cold workability. Mechanical property data were obtained at room temperature and 2000°F on niobium containing additions of Ti, Zr, Hf, V, Mo, and W. Of the elements studied, vanadium additions were the most effective strengtheners. Nb-Zr and Nb-Hf alloys having high oxygen contents exhibited very good high temperature properties. It appeared that the interaction of oxygen with the alloy addition may be responsible for the high strength. Tensile data were obtained on alloys having ternary and quaternary additions of Ti, Zr, Hf, and Mo. Nb-Ti-Zr-Hf alloys exhibited yield strengths well in excess of 40,000 psi at 2000°F. Welding studies on a number of niobium alloys containing additions of Ti, Zr, Hf, V, and W were carried out. Satisfactory welds were obtained in all the alloys studied. Bend test data were obtained on the weld specimens. (auth)

#### 12844 AEC-tr-4036

OBSERVATIONS MADE DURING ELECTROLYTIC POLISHING OF METALS. H. Mohlberger. Translated for Oak Ridge National Lab. from Metal 11, 756-61(1957). 29p. JCL.

Phenomena which were observed during the electrolytic polishing of copper and brass in phosphoric acid are described. The influence of a variation of the flow velocity of the electrolyte on the shape of the current-voltage curve and related changes in the state of the surface at the anode



to be polished was studied. The maximum metal solution rate was found to depend upon the flow rate of the electrolyte and increased with the latter. The formation of solid covering layers and variations in the polishing voltage range are discussed. Explanations of the polishing mechanism are discussed. The influence of additives to the polishing electrolyte was investigated. (C.J.G.)

#### 12845

STUDY OF LOW SOLUBILITIES IN A FUSED METAL BY SAMPLING AT CONSTANT TEMPERATURE FROM THE LIQUID PHASE: APPLICATION TO THE GALLIUM-SODIUM SYSTEM. Émile Rinck and Pierre Feschotte. *Compt. rend.* 250, 1489-91(1960) Feb. 22. (In French)

The low solubility of any solid constituent in a fused metal can be measured by sampling the fused metallic phase at a constant temperature and then analyzing the samples. Factors affecting the sampling technique were studied using the gallium-sodium system. (tr-auth)

#### 12846

LUBRICANTS FOR NUCLEAR ENGINEERING. Peter Jost and W. Bye (K. S. Paul (Molybdenum Disulphide) Ltd., London). *Nuclear Energy* 14, 160-61(1960) Apr.

Applications and advantages of  $\text{MoS}_2$  in the field of atomic energy as a lubricant are discussed. This compound is used to lubricate machinery subjected to high levels of radiation and intense heat for extended periods of time. The normal temperature range of  $\text{MoS}_2$  is  $-300$  to  $+800^\circ\text{F}$ . In vacuum or inert gases, the upper limit is  $2100^\circ\text{F}$ . Reports show that during press-fit-tests using irradiated and non-irradiated  $\text{MoS}_2$  as a lubricant, the coefficient of friction was 0.057 and 0.056, respectively. When running red hot, the coefficient of friction of a film created *in situ* is around 0.07. (B.O.G.)

#### 12847

ZONE LEVELING OF BORON INTO ZONE-MELTED IRON. B. F. Oliver and Amos J. Shafer (Pennsylvania State Univ., University Park). *Trans. Met. Soc. AIME* 218, 194-6 (1960) Apr.

Pure boron was successfully single-pass zone leveled into zone-melted iron in a floating-zone apparatus. A zone-stabilizing direct current of 120 amp was passed through the bar during zone leveling. The effective redistribution coefficient for boron in iron is  $0.16 \pm 0.03$ . (auth)

#### 12848

THE CRYSTALLOGRAPHY OF THE AUSTENITE-MARTENSITE TRANSFORMATION. THE  $\{111\}$  SHEAR SOLUTIONS. M. S. Wechsler (Oak Ridge National Lab., Tenn.) and T. A. Read and D. S. Lieberman (Univ. of Illinois, Urbana). *Trans. Met. Soc. AIME* 218, 202-7 (1960) Apr.

The graphical method is applied to the austenite-martensite transformation. The undistorted planes are determined for the lattice invariant shear on the (111) austenite plane. The solutions are discussed in terms of their degeneracy and their applicability to the formation of (225) martensite in steel. (auth)

#### 12849

REACTIVE METALS. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958. W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959. 624p.

The list of reactive metals includes titanium, zirconium, hafnium, thorium, vanadium, columbium, tantalum, molybdenum, tungsten, uranium, and rhenium. At least one paper pertaining to each of these materials is included. Precau-

tions were taken to ensure that no one metal monopolized the conference. Separate abstracts have been prepared for 23 of the 37 papers included. (B.O.G.)

#### 12850

THE POWDER METALLURGY PREPARATION OF SOME ZIRCONIUM ALLOYS. Henry H. Hausner (New York, N. Y.) and Herbert S. Kalish (Olin Mathieson Chemical Corp., New Haven). p.73-92 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

A method is described in which a dense homogeneous alloy is prepared by powder metallurgy. Beryllium, uranium, and zirconium are discussed, with emphasis on zirconium. The effects of sintering time and temperature on the microstructure are given for uranium-zirconium and beryllium-zirconium alloys. (B.O.G.)

## Corrosion

#### 12851 AFOSR-TN-60-387

Princeton Univ., N. J. Forrestal Research Center. OXIDATION OF IRON-CHROMIUM ALLOYS. Metallurgy Report No. 22. D. Lai, R. J. Borg, M. J. Brabers, J. D. Mackenzie, and C. E. Birchenall. Feb. 29, 1960. 37p. Contract AF49(638)-533.

The rates of oxidation of iron alloys containing 0.2 to 10% chromium have been measured from 750 to  $1025^\circ\text{C}$ . The nature of the products has been investigated by metallography, x-ray-diffraction and chemical analysis. At very low chromium concentrations there is a small increase in the oxidation rate compared with pure iron for short times, but for longer times the rate diminishes. The oxidation rate at a given temperature diminishes with increasing chromium concentration. The rates are not given by any simple rate law, presumably because the products contain many pores and cracks. The accelerations in rate during an isothermal measurement do not occur at reproducible times or average thicknesses, which suggests that scale fracture plays an important role. A mechanism for scale embrittlement by chromium is proposed. The ways in which chromium might contribute to a reduced rate of oxidation of iron are discussed. (auth)

#### 12852 CEA-BIB-2

France. Commissariat à l'Énergie Atomique, Paris. LA CORROSION SOUS CONTRAINTE. (Stress Corrosion). Bibliography No. 2. J. Dirian. 1959. 52p.

An abstract bibliography is presented with 240 references to published literature. The references deal with stress corrosion from both a theoretical and practical point of view, with regard to steels, light alloys, and other metals and alloys. (T.R.H.)

#### 12853 HW-56588

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

RESULTS OF NaK CAPSULE FAILURES IN HOT WATER FLOW TUBE. J. W. Weber. Sept. 12, 1958. 3p.

Contract AT(45-1)-1350. OTS.

Results of deliberately caused failure in NaK filled aluminum body capsules containing small diameter uranium rods are presented. Autoclave and flow tube tests results are included. It is noted that the most significant result of these tests is that there is no distortion or capsule swelling from the NaK-water reaction which might cause blockage or injury to reactor process tubes. (J.R.D.)

**12854** HW-60998

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

HEAT TRANSFER TESTING. D. R. Doman, J. F. Hokenson, and R. J. Lobsinger. July 7, 1959. 7p. Contract AT(45-1)-1350. OTS.

Several tests are being performed to investigate the role of heat transfer in corrosion processes. These tests are measuring both corrosion rates of metals (Zircaloy-2 and X-8001 aluminum) under heat transfer, and the temperature rise associated with the buildup of the corrosion product. A brief description of these tests is given. (W.L.H.)

**12855** LS-40

Israel. Atomic Energy Commission, Tel-Aviv.

LITERATURE SURVEY ON AQUEOUS CORROSION OF URANIUM AND ITS ALLOYS. ITS MECHANISM AND ITS PREVENTION IN NUCLEAR REACTORS. May 1959. 18p.

A bibliography is presented on aqueous corrosion of U and U alloys, the mechanism, and prevention in nuclear reactors. The references were collected from Chemical Abstracts, Vols. 48-52 and Vol. 53, Nos. 1-3 (1954-59); Metallurgical Abstracts, Vols. 19-25 (Sept. 1951-Aug. 1958), Vol. 23 missing, and Vol. 26, Nos. 1-5; and Nuclear Science Abstracts, Vols. 1-12 and Vol. 13, Nos. 1-3 (1948-1959). 182 references. (T.R.H.)

**12856** LS-46

Israel. Atomic Energy Commission, Tel-Aviv.

LITERATURE SURVEY ON THE CORROSION OF STAINLESS STEELS IN NITRIC ACID (THE EFFECT OF TEMPERATURE, CONCENTRATION AND THE PRESENCE OF SEVERAL IONS IN THE SOLUTIONS). Aug. 1959. 10p.

A bibliography is presented on the corrosion of stainless steels by  $\text{HNO}_3$  as affected by temperature, concentration, and the presence of other ions in the solution. The sources of information used were Nuclear Science Abstracts 1948-1959 (issue No. 10), Chemical Abstracts 1948-1959 (issue No. 9), ASM Review of Metal Literature 1944-1956, Bibliographic Survey of Corrosion 1948-1955, and Corrosion Abstracts 1956-1959 (issue No. 6). 84 references. (T.R.H.)

**12857** LS-48

Israel. Atomic Energy Commission, Tel-Aviv.

LITERATURE SURVEY ON AQUEOUS CORROSION OF STAINLESS STEELS (WITH A SPECIAL REFERENCE TO CORROSION IN BOILING AND PRESSURISED HIGH-PURITY WATER). Aug. 1959. 10p.

A bibliography is presented on aqueous corrosion of stainless steels with special reference to corrosion in boiling and pressurized high-purity water. The information sources were Nuclear Science Abstracts 1948-1959 (issue No. 10), Chemical Abstracts 1948-1959 (issue No. 9), ASM Review of Metal Literature 1944-1956, Bibliographic Survey of Corrosion 1948-1955, and Corrosion Abstracts 1956-1959 (issue No. 6). 83 references. (T.R.H.)

**12858**

HARD-WATER SCALING OF FINNED TUBES AT MODERATE TEMPERATURES. J. G. Knudsen and H. K. McCluer (Oregon State Coll., Corvallis). Chem. Eng. Progr. 55, Symposium Ser. No. 29, 1-4(1959).

With the increasing use of finned tubes in industrial heat transfer equipment it is important to know their heat transfer characteristics. This investigation is concerned with a study of the rate of scaling of transverse finned tubes in a double-pipe heat exchanger. (auth)

**12859**

CORROSION OF IRON AND STEELS IN LIQUID METALS. I. STATIC CORROSION TEST. Y. Imai and T. Ishizaki

(Tohoku Univ., Sendai). J. Atomic Energy Soc. Japan 2, 96-101(1960) Feb. (In Japanese)

The modes of attack by liquid metal are direct alloying, dissolution, intergranular penetration, corrosion by contaminants, and others. Microscopic examination of metallographically polished surface was adopted to investigate the attack of liquid metals on iron and steels. The reliability of the experimental method, the effect of oxygen and the effect of stabilizer of oxygen were examined. (auth)

**12860**

THE OXIDATION OF NIOBIUM. B. B. Argent and B. Phelps (Univ. of Sheffield, Eng.). J. Inst. Metals 88, 301-4(1960) Mar.

The oxidation rates of pure niobium were measured in dry and moist oxygen and air over the range 400 to 1050°C. It was found that: (1) the form of the oxidation-rate/temperature curves for niobium is dependent on the specimen shape and dimensions; (2) niobium oxide in contact with niobium shows an anion-deficient lattice at temperatures near 700°C; (3) a cation-deficient lattice is formed in the region of 450°C, but it is suggested that this is an effect dependent on the formation of metastable oxides; and (4) the formation of non-stoichiometric oxides accelerates oxidation. Apparent anomalies in the oxidation rates can be explained by departures from stoichiometry in the oxides. (auth)

**12861**

NATURE AND PROPERTIES OF THE THIN OXIDE FILM FORMED ON ZIRCONIUM AND ZIRCALOY. E. A. Gulbransen and K. F. Andrew (Westinghouse Research Labs., Pittsburgh). p.465-76 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Hydrogen permeation is suggested as a method for study of the protective oxide films formed on zirconium and Zircaloy-2. The standard test conditions were 150°C and 2.4 cm Hg of hydrogen pressure. Experiments were made on various surface preparations and pretreatments of the metal. The time course of the hydrogen reaction was found to be very sensitive to the properties of the protective oxide film. (auth)

**12862**

THE OXIDATION OF COLUMBIUM-BASE AND TANTALUM-BASE ALLOYS. A. B. Michael (Fansteel Metallurgical Corp., Chicago). p.487-507 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The oxidation of arc-melted niobium, tantalum, and alloys of these metals with Ti, Zr, W, Mo, V, Cr, Co, Ni, Fe, Si, and Al was investigated. Alloys were surveyed by exposure to flowing air at 2000°F for 16 hr and selected compositions were investigated for other temperatures and times. The highest resistances to scaling were observed for Nb-Cr-Co, Nb-Ta-Cr-Co, and Ta-Cr-Co alloys. For these alloys, lower resistances to scaling were observed when Fe was substituted for Cr and Ni for Co. Other alloys which had significant resistances to scaling at 2000°F were: Ta-Ti-Co, Ta-Co, Ta-Ni, Nb-W, Nb-Ta, Ta-Ti, Nb-Mo, Nb-Cr, and Nb-Ti-W, in the order of decreasing resistances. A minimum rate of scaling was observed in the Nb-Ta system at 20% Ta. This alloy retained the useful properties of niobium and was more resistant to scaling than niobium and tantalum at temperatures of 1500 to



2000°F. At 2000°F the stress-to-rupture and fatigue properties of the Nb-20% Ta alloy were superior to those of niobium metal. (auth)

### 12863

3<sup>e</sup> COLLOQUE DE MÉTALLURGIE SUR LA CORROSION (SÈCHE ET AQUEUSE). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959. [3rd Metallurgical Colloquium on Corrosion (Dry and Aqueous). Held at Saclay June 29-30 and July 1, 1959]. Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. 244p.

Twenty papers are included. Separate abstracts have been prepared for each. (T.R.H.)

### 12864

RECENT DEVELOPMENT OF IDEAS OF THE OXIDATION OF METALS. Jacques Bénard (Université, Paris). p.1-8 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

A review is made of the different attempts made to draw up a general theory on the oxidation of metals: Pilling-Bedworth, Cabrera-Mott, Wagner. It is shown that the basic process of oxidation reactions is often masked by secondary phenomena whose role often appears decisive in the evolution of the reaction. A more particular examination of the results obtained recently in the study of certain of these phenomena: germination, surface diffusion, and chemisorption is given. (auth)

### 12865

ATTACK OF GRAPHITE BY GASEOUS IMPURITIES IN A HIGH TEMPERATURE, HELIUM COOLED, GRAPHITE MODERATED REACTOR. J. E. Antill and K. A. Peakall (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.9-18 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In English)

Out-of-pile experiments were done to determine the kinetics of the oxidation of graphite at 900 to 1000°C in argon containing small amounts of oxygen, water vapor, carbon dioxide, hydrogen, and carbon monoxide. The reactivity of the gases decreased in the order oxygen, water vapor, carbon dioxide. The reaction rates increased with temperature and with the partial pressure of the oxidizing gas, while hydrogen and carbon monoxide inhibited the attack. The relationships between the reaction rates and the partial pressures of the gases are in good agreement with theory and previous work. (auth)

### 12866

DIFFUSION MECHANISMS AND GASEOUS CORROSION. W. J. Moore (Indiana Univ., Bloomington). p.19-22 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In English)

A general survey is given of the various types of defect mechanism that may be applicable in diffusion in solid oxides and sulfides at high temperatures. It is suggested that defects associated with departures from stoichiometry may often be of less importance than those due to thermal disorder of the Schottky or Frenkel type. Next the relation of tracer diffusion coefficients to parabolic rate constants is

restated in the formulation of Wagner. It is shown that this formulation implies a linear proportionality between rate and driving force for the reaction, and the condition that must be met for this to hold is specified and discussed. (auth)

### 12867

CORROSION INHIBITION OF MAGNESIUM HEATED IN WET AIR, BY SURFACE FLUORIDATION. R. Caillat, R. Darras, and D. Leclercq. p.23-36 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

The maximum temperature (350°C) of magnesium corrosion resistance in wet air may be raised to 490 to 500°C by the formation of a superficial fluoride film. This can be obtained by two different ways: either by addition of HF to the corroding medium in a very small proportion such as 0.003 mg/liter, at atmospheric pressure, or by dipping the magnesium in a dilute aqueous solution of nitric and hydrofluoric acids at room temperature before exposing it to the corroding atmosphere. In both cases the corrosion inhibition is effective over a very long time, even several thousand hours. (auth)

### 12868

SELECTION OF ALLOYS WHICH RESIST CORROSION AT HIGH TEMPERATURES. J. Genilloud. p.37-51 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Results are given from tests carried out in the temperature range 700 to 1100°C for 2000 hours. Test materials were chosen from within the range of industrial refractory alloys. The types of alloys tested, the experimental techniques used, and the conclusions drawn are included. The influences of such factors as composition, fabrication, and treatment are discussed. (D.E.B.)

### 12869

OXIDATION FILM MORPHOLOGY. PART I. J. Païdassi (Commissariat à l'Énergie Atomique, Paris). p.71-81 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

After studying the oxidation of several pure polyvalent metals (Fe, Cu, Mn, Ni, U) and of their oxides at high temperature and atmospheric pressure, how to modify the usual representation of the oxide film (a piling of different oxide layers, homogeneous on a micrographic scale with a equiaxial cristallisation, free of mechanical tensions, with flat boundary surfaces) to have it nearer to reality is suggested. The study of the real micrographic structure of the oxidation film is described and examples of precipitation in the oxides during the cooling of the oxidized sample are given. (auth)

### 12870

OXIDATION FILM MORPHOLOGY. PART II. J. Païdassi (Commissariat à l'Énergie Atomique, Paris). p.83-95 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organisé à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

A study of the special features of different interfaces of the real scale was made and examples of its growing due to the metallic substratum are given. (auth)

#### 12871

OXIDATION FILM MORPHOLOGY. PART III. J. Paidassi (Commissariat à l'Énergie Atomique, Paris). p.97-100 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Examples of appearance of an oxide as isolated crystals and the plastic deformations of the oxidized samples are studied. (auth)

#### 12872

CERTAIN FACTORS IN THE CORROSION OF STAINLESS STEELS IN AQUEOUS SOLUTIONS. L. Colombier (Compagnie des Ateliers et Forges de la Loire, Unieux, France). p.111-25 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

A study was made of some of the types of corrosion which can affect austenitic stainless steels. Considered successively are: intergranular corrosion, pitting corrosion, stress corrosion, and the action of corrosion accelerators and inhibitors. For each case the phenomena are described, their mechanism is studied, and theories are brought forward to explain them. The practical solutions which can be applied are described. (auth)

#### 12873

THE INFLUENCE OF HYDROGEN ON THE CORROSION OF ZIRCONIUM AND ITS ALLOYS IN HIGH TEMPERATURE WATER. J. N. Wanklyn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.127-35 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

The influence of hydrogen on the corrosion of zirconium and its alloys was studied in two types of experiment; cathodic polarization during corrosion in water at 325°C and comparison of the oxidation of zirconium at 325°C in dry oxygen and in steam. Weight gain was used as the measure of corrosion, and also the protective character of the oxide films was estimated by measuring their capacities. Cathodic polarization was found to diminish the protective character of the films on zirconium and some of its alloys; but other alloys, including Zircaloy-2, were more resistant to polarization. The percentages of the cathodic hydrogen which entered the various alloys were very different, but there was no relation between these values and the extent of damage to the oxide films. The protective elements in Zircaloy-2 appear to act by stabilizing the oxide against the harmful effect of hydrogen, rather than by preventing the latter's entry into the metal. It is shown that, in the oxidation of zirconium, the presence of hydrogen causes increased cracking of the oxide, films formed in steam being, at a given thickness, less protective than those formed in dry oxygen. It seems, that in the initial stage of oxidation hydrogen can increase the rate of ionic diffusion in the oxide; but this is not in agreement with the final rates of oxidation formed in the two gases. The present picture of the oxidation

process is probably too simple; and the mechanical properties of oxide films on metals require further study. (auth)

#### 12874

STUDY OF THE PRECIPITATION OF CHROMIUM CARBIDE RESPONSIBLE FOR INTERCRYSTALLINE CORROSION IN AUSTENITIC STAINLESS STEELS. Henri Hatwell (European Research Associates, Brussels). p.137-46 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Correlation between the morphology of the chromium carbide precipitate  $\text{Cr}_{23}\text{C}_6$ , its conditions of growth in the alloy, and intergranular corrosion behavior is attempted. Carbides of dendritic shape are shown to be mainly responsible for intergranular corrosion. Appropriate modifications of Bain's theory (chromium depleted zone) are suggested. (auth)

#### 12875

CORROSION BY PURE WATER AT HIGH TEMPERATURE OF STAINLESS STEELS. E. Pouillard (Compagnie des Forges, Montluçon, France). p.147-60 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

The effects of superficial corrosion and corrosion under stress are treated. The ten steels studied were either very low in carbon content or stabilized with respect to Ti or Nb, and contained Mo. The methods of testing and the apparatus are described. Two types of micro-autoclaves, machined entirely in the steel under investigation, were developed, one for superficial corrosion and the other for corrosion under stress. A special procedure for their use is given in each case. The tests on superficial corrosion, carried on over a period of one year both in the vapor and the liquid phase, show that the steels have good resistance to intergranular corrosion and that the essential type of corrosion observed was the formation of pinholes. It was shown that the number and depth of the pinholes was related to the additive content of the surface examined. Corrosion under stress at 350°C is nil, even after a year, for a pressure of the order of  $3/4 E_{0.2}$ . However in the case of overpickled steels, the appearance of an appreciable intergranular corrosion was observed. (auth)

#### 12876

STRESS CORROSION CRACKING OF INCONEL IN HIGH TEMPERATURE WATER. H. Coriou, R. Grall, M. Le Gall, and S. Vettier (Commissariat à l'Énergie Atomique, Paris). p.161-9 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Some inconel samples were subjected to hot water corrosion testing (350°C), under stress slightly above the elastic limit. It was observed that different types of alloys with or without titanium, could suffer serious intergranular damage, including a complete rupture, within a three months period. In one case, an unusual intergranular phenomenon which appeared quite different from common intergranular corrosion was observed. (auth)

#### 12877

"KNIFE EDGE" CORROSION OF CERTAIN STAINLESS



**STEEL WELDS.** J. Hochmann (Compagnie des Ateliers et Forges de la Loire, Unieux, France). p.171-4 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

The phenomena of intergranular corrosion of certain titanium or niobium stabilized stainless steels in a zone immediately adjacent to the weld was observed to take place in boiling nitric acid of various concentrations. This corrosion affects zones which are heated to temperatures in the neighborhood of 1300°C during welding and takes place in 18/10 stainless steels which are stabilized by titanium or niobium but not in unstabilized stainless steels which have the same carbon content. It takes place in untreated welded fabrications and also in fabrications which have been stabilized and stress released by heating to 800 to 900°C. The sensitivity to knife edge corrosion is independent of the sensitivity to the intergranular corrosion caused by heating to 500 to 800°C; it only affects steels containing more than 0.06% carbon and takes place no matter what the ratios titanium-carbon or niobium-carbon. Some examples of this corrosion are described and attempts to explain why it takes place are made. (auth)

#### 12878

**PRECIPITATES, FRAGILITY AND INTERGRANULAR CORROSION OF 18-8 STAINLESS STEEL.** J. Plateau, G. Henry, and C. Crussard (Laboratoires de l'I.R.S.I.D., Saint-Germain-en-Laye, France). p.185-99 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Morphology of intergranular and intercrystalline chromium carbides formed during annealing of 18-8 stainless steels, influence of the duration and temperature of the annealing process, influence of the carbon content and the possibility of an epitaxial or coherent growth were studied. Intergranular precipitates lead to intergranular fragility at low temperature. Microfractography shows that the mechanism of the production of intergranular cracks is similar to that of ductile ruptures. A study of the evolution of mechanical properties at -196°C, as a function of the duration and temperature of annealing, was made. (auth)

#### 12079

**THE IRSID SEAWATER CORROSION TESTING STATION—PRINCIPAL RESULTS OBTAINED AT BIARRITZ.** A. Hache (I.R.S.I.D., Saint-Germain-en-Laye, France). p.202-4 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

The reasons are given which led to the choice of Biarritz as the site of the Seawater Corrosion Testing Station. The interest of the results obtained and the working facilities in this station explain its extension; it figures among the most important in France. (auth)

#### 12880

**FIXATION OF RADIOACTIVE SULPHUR ON THE SURFACE OF IRON INFLUENCE IN ELECTROCHEMICAL CORROSION.** B. Le Boucher (Institut Français du Pétrole, Rueil-Malmaison, France) and C. Libanati and P. Lacombe (Centre de Recherches Métallurgiques de l'Ecole des Mines, Paris). p.205-15 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay,

France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

Sulfur can be fixed on the surface of iron at temperatures around normal, if this surface is not already covered by oxygen. The surface may be prepared by annealing in pure hydrogen and thus a well defined fixation obtained. It is shown that the quantity of sulfur fixed is closely related to the crystal orientation: maximal for grains of orientation close to (111), minimal for those around (110). From a study of the variation of contact potentials of the surfaces investigated, three types of fixation may be distinguished: the sulfur starts by being adsorbed, the process being partly physical and partly chemical. After a certain adsorption time sulfide is formed at the expense of the physically and chemically adsorbed layers, which disappear. Sulfur adsorbed physically or fixed in the form of sulfide has no appreciable action on the corrosion of iron in hydrochloric acid. On the other hand sulfur adsorbed chemically produces a catalytic increase in corrosion under the same conditions. (auth)

#### 12881

**PRESENT STATE OF OUR KNOWLEDGE ON THE CORROSION OF THE STEELS BY HYDROGEN SULPHIDE.** E. Herzog (Acieries de Pompey, France). p.217-39 of "3<sup>e</sup> Colloque de Métallurgie sur la Corrosion (Sèche et Aqueuse). Organise à Saclay les 29-30 juin et 1<sup>er</sup> juillet 1959." Saclay, France, Centre d'Études Nucléaires and Amsterdam, North Holland Publishing Co., 1960. (In French)

It is observed that electromotive forces of about 0.3 v are set up between bare steels and steels coated with sulfides formed in the course of corrosion in H<sub>2</sub>S under humid conditions. The residual currents from these couples correspond to the weight losses obtained. Sulfides with an excess of sulfur Fe/S = 1:1.25, of the pyrrhotine type, formed in the crude gas from Lacq, are compact and slow down the attack. Breakages under H<sub>2</sub>S and by cathodic charging are related to the concentration gradient of protons which is set up in the steel. Rapid saturation produces additional internal stresses which, added to the external stresses, bring about the breakage. Slow saturation either does not lead to breakages, or delays them considerably. Finally, corrosion by sodium sulfide (in an alkaline medium) can be speeded up by anodic attack. This takes place chiefly at the grain boundaries. When external stresses are applied this reagent brings about the rupture of quenched or incompletely annealed steels, without appreciable diffusion of hydrogen. It can be concluded that breakages in H<sub>2</sub>S depend not only on the diffusion of protons, but also on the peculiar attack under stresses obtained in the presence of sulfur ions. (auth)

## Fabrication

#### 12882 AD-229174

Chromalloy Corp., White Plains, N. Y.  
**EXPLOSIVE FORMING OF REFRACTORY METALS.**  
Bi-Monthly Report No. 1 [for] June 30, 1959 through August 31, 1959. Richard L. Wachtell. Sept. 1, 1959. 17p. Contract NOas-59-6265-c.

A literature survey of the explosive forming of refractory metals is summarized. Test dies were designed and their fabrication was started. (C.J.G.)

#### 12883 AERE-M-619

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE OCCURRENCE OF CHLORINE IN ELECTRODE-POSITED BERYLLIUM. R. G. Bellamy. Feb. 1960. 17p. BIS.

The purification processes for electrolytic beryllium flake are reviewed. The mode of occurrence of chlorine in electrolytic beryllium is examined. The chlorine content of electrolytic beryllium flake was found to be reduced by crushing and leaching to an irreducible minimum of 200 to 300 ppm. Three possible ways are suggested in which this residual chlorine could be present: surface films on the beryllium powder, chlorine dissolved in the lattice, and discrete chlorine-containing particles enclosed by the metal. (C.J.G.)

#### 12884 DEGIS-93(R)

United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England.

BIBLIOGRAPHY ON WELDING OF ZIRCALOY-2. G. I. Maughan, comp. Jan. 11, 1960. 7p. BIS.

A bibliography containing 40 references from literature published between 1947 and January 1960 is presented on the welding of Zircaloy-2. (C.J.G.)

#### 12885 DMIC-Memo-47

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

SELECTED REFERENCES ON MAKING HIGH-TEMPERATURE ALLOYS BY POWDER METALLURGY. Vincent D. Barth. Mar. 18, 1960. 7p. (PB-161197). OTS.

A bibliography is presented which contains selected references of basic interest in powder-metallurgy processes. Also included are references on basic theory, transition-metal interstitial-atom alloys, and powder-metallurgy of molybdenum and its alloys. (auth)

#### 12886 DMIC-Memo-48

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

BRAZING FOR HIGH-TEMPERATURE SERVICE. A. F. Haskins and R. M. Evans. Mar. 29, 1960. 15p. (PB-161198). OTS.

A summary of advancement in the field of brazing for service temperature in excess of 600°F is presented. Data on service temperatures for some standard brazing alloys are included along with data on nickel-base and noble-metal-base brazing alloys. (J.R.D.)

#### 12887 DMIC-Memo-51

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

BIBLIOGRAPHY ON EXPLOSIVE METAL WORKING. C. T. Olofson and F. W. Boulger. Apr. 7, 1960. 18p. (PB-161201). OTS.

A bibliography containing 210 references is presented on explosive metal working. The references pertain to literature published prior to April 4, 1960. (C.J.G.)

#### 12888 HW-53351

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

DESIGN COMPLETION REPORT; INTERLOCKING CONTOUR TOOLING SYSTEM. J. W. Nickolaus. Oct. 25, 1957. 9p. OTS.

A tooling system designed to produce the interlocking contour on I and E fuel elements is described. Drawing numbers are included. (J.R.D.)

#### 12889 HW-53616

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

POST COMPLETION REPORT—FUEL ENGINEERING

PILOT PLANT SEMIWORKS—306 BUILDING. S. M. Gill. Nov. 13, 1957. 8p. Contract AT(45-1)-1350. OTS.

Process and construction improvements to the fuel element pilot plant semiworks are presented. The pilot plant is a one-canning-line fuel element fabrication facility for the production of internally and externally cooled uranium fuel elements. A flowsheet is presented showing the equipment layout of the facility. (C.J.G.)

#### 12890 JPL-30-8

California Inst. of Tech., Pasadena. Jet Propulsion Lab. WELDED TITANIUM CASE FOR SPACE-PROBE ROCKET MOTOR. A. J. Brothers, R. A. Boundy, H. E. Martens, and Leonard D. Jaffe. Sept. 3, 1959. 11p. Contracts DA-04-495-Ord 18 and NASw-6.

The high strength-to-weight ratio of titanium alloys suggests their use for solid-propellant rocket-motor cases for high-performance orbiting or space-probe vehicles. Fabrication of a 6-in.-diam., 0.025-in.-wall rocket-motor from the 6Al-4V titanium alloy is described. The rocket-motor case, used in the fourth stage of a successful JPL-NASA lunar-probe flight, was constructed using a design previously proven satisfactory for Type 410 stainless steel. The nature and scope of the problems peculiar to the use of the titanium alloy, which effected an average weight saving of 34%, are described. (auth)

#### 12891 KAPL-M-DBK-6

Knolls Atomic Power Lab., Schenectady, N. Y. BUTT WELDING OF COPPER TO STAINLESS STEEL SHEET. D. B. Kittle and J. M. Gerken. Feb. 1960. 10p. Contract W-31-109-Eng-52. OTS.

Development of a technique for producing ductile butt welds between copper and type 304 stainless steel is described. Inert gas tungsten-arc welding process was used on samples of the two materials which were 0.050, 0.075, and 0.110 inches thick. Results showed that metal fixturing could be achieved without metal backing if proper heat balance is obtained on each material. (J.R.D.)

#### 12892 KAPL-M-WAO-5

Knolls Atomic Power Lab., Schenectady, N. Y. THE ARC WELDING OF END CAPS TO RECTANGULAR CO-EXTRUDED IRRADIATION SPECIMENS. W. A. Owczarski and J. F. Bollinger. Jan. 1960. 23p. Contract W-31-109-Eng-52. OTS.

A process for end capping co-extruded B<sub>2</sub>C-Zircaloy-2 poison strips by arc welding is described. The maximum strength attainable in a weld was found to be limited by the thickness of the clad and the maximum boron specified. Boron-free welds were possible if welding parameters were properly controlled. (C.J.G.)

#### 12893 LS-62

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON ALUMINIUM CLADDING OF NICKEL-PLATED URANIUM REACTOR FUEL ELEMENTS. Aug. 1959. 4p.

A bibliography is presented on Al cladding of Ni-plated U reactor fuel elements. The references were collected from *Nuclear Science Abstracts*, Vols. 4-12, 1950-58, and Vol. 13, Nos. 1 to 10, *Chemical Abstracts*, Vols. 50-52, 1956-58, and Vol. 53, Nos. 1-11, *Metallurgical Abstracts*, Vols. 19-25 and Vol. 26 up to July 1959, and reports in the Israel Atomic Energy Commission Library. 21 references. (T.R.H.)

#### 12894 NP-8544

Aeroprojects, Inc., West Chester, Penna. FUNDAMENTALS OF ULTRASONIC WELDING. PHASE I. Final Report Covering the Period December 1, 1957-December 1, 1958. J. Byron Jones, Nicholas Maropis,



John G. Thomas, and Dennison Bancroft. May 1959. 110p. Contract NOas-58-108-c. (RR-59-105).

The investigations are oriented to the development of a phenomenological theory of ultrasonic or vibratory welding that will account for the observed effects. Phase I of an extended research program is concerned with the development of techniques to permit quantitative investigation of the internal cyclic stresses, transient temperatures, and net energy associated with the generation of such metallurgical bonds. Preliminary information on the energy required to generate ultrasonic welds in several materials was obtained with a view to predicting ultrasonic weldability in terms of the more familiar material properties. (auth)

#### 12895 NP-8552

Beryllium Corp., Reading, Penna.

BERYLLIUM CASTING—PHASE II. Interim Technical Engineering Report No. 5 [for] Period September 20 to December 19, 1959. Paul M. Cohen and R. C. Harris. 32p. ASC Project No. 7-643. Contract AF33(600)-37902.

The effects of superheat and the rate of cooling on beryllium ingot structure were investigated. This was done by pouring a series of heats, each with a varying degree of superheat, into a composite preheated mold. The results indicate that the columnar grain size was reduced appreciably from that exhibited by ingots made in previously completed portions of this program. The grain size of the former ingots seems to be unaffected, on a macrographic scale at least, by the thermal conditions imposed. The grain size does not appear to be sensitive to the different mold materials employed, although a slight structure gradient was observed from top to bottom of the ingots cast. Hardness readings were found to be unreliable due to metal cracking near the test indentation. Research on the effects of germanium as an alloying addition and tantalum nitride and tungsten carbide as inoculants was initiated during this quarter. Extensive equipment modifications were undertaken to facilitate these areas of study. (auth)

#### 12896 SCTM-376-59(25)

Sandia Corp., Albuquerque, N. Mex.

THE STAKING METHOD OF DEFORMING METALS AND JOINING PARTS. R. P. Lewis. Feb. 10, 1960. 24p. OTS.

The tools and methods used to perform staking operations are described. Engineering aspects, such as cold flow of material, work hardening, and selection of materials are discussed. Special requirements of the staking process are reported, and typical applications are described. (auth)

#### 12897 SEP-157

Sylvania Electric Products Inc. Atomic Energy Div., Bay-side, N. Y.

THE FABRICATION OF HOLLOW CYLINDRICAL FUEL ELEMENTS FROM URANIUM POWDER. J. Fugardi, R. E. King, and H. M. McCullough. June 7, 1954. Decl. Mar. 2, 1960. 25p. Contract AT-30-1-GEN-366. OTS.

A description is given of the die designs, dry boxes, loading cans, vacuum pots, and other experimental equipment used for fabricating hollow fuel slugs from uranium metal powder. The details of equipment operation are also given, including the die lubrication, die loading, pressing, and inspection procedures. (auth)

#### 12898 WAPD-RM-96

Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.

ZIRCONIUM INGOTS ARC MELTED FROM VARIOUS TYPES OF ZIRCONIUM SCRAP. E. S. Foster and W. J.

Hurford. Nov. 13, 1951. Decl. Feb. 16, 1960. 8p. Contract AT-11-1-GEN-14. OTS.

Experiments are described in which the problems encountered in melting and cleaning scrap zirconium were investigated. The ingots made in these experiments were evaluated to determine if they were within the specification limits of hardness, corrosion resistance, and chemical composition for use in the Mark I core. Data and conclusions are included. (J.R.D.)

#### 12899

NEUTRON SOURCES FROM THE BERYLLIUM REDUCTION OF PLUTONIUM DIOXIDE. G. G. Michaud and R. R. Boucher (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Can. J. Phys.* 38, 555-64(1960) Apr.

Sintered neutron sources were prepared by reacting plutonium dioxide with beryllium metal powder. The reaction, forming a plutonium-beryllium alloy, proceeded very slowly at 750°C but was nearly complete at 850°C. Sintered, non-friable agglomerates were obtained by heating the reacted mixtures at 1250 or 1450°C, depending on the beryllium concentration. In the composition range of Be/Pu atom ratios of 13:1 and above, the neutron output from the sintered products were from 93 to 98% of the theoretical neutron yield. The presence of BeO in the sinters was found to have negligible effect on the neutron output of the alloy. Studies of some factors affecting neutron output or sinter quality are reported. (auth)

#### 12900

METHOD FOR THE ELECTROLYTIC POLISHING OF URANIUM DIOXIDE. Alexandre Portnoff and Henry Frisby. *Compt. rend.* 250, 1486-8(1960) Feb. 22. (In French)

A method for the electrolytic polishing and etching of uranium dioxide was studied. It was applied to the micrographic examination of fritted uranium oxide pellets. A detailed study was made of the microstructure. (tr-auth)

#### 12901

TEMPERING COLD-DEFORMED K40HXM ALLOYS. B. G. Livshits and N. G. Makhukov. *Fiz. Metal. i Metalloved.* 8, 400-405(1959) Sept. (In Russian)

Measurements of K40HXM (Fe-Co-Cr-Ni) alloy hardness, electroconductivity, thermal expansion, elastic constants, and internal friction show that this type alloy is subject to two separate aging stages: at 300 to 550°C resulting in K-state formation and at 550 to 700°C resulting in solid second phase solution and recrystallization. (R.V.J.)

#### 12902

NICKEL-ALUMINUM ALLOY COATINGS PRODUCED BY ELECTRODEPOSITION AND DIFFUSION. Dwight E. Couch and Jean H. Connor (National Bureau of Standards, Washington, D. C.). *J. Electrochem. Soc.* 107, 272-6(1960) Apr.

Nickel-aluminum alloy coatings were produced by diffusion of aluminum electrodeposited over nickel. The aluminum was plated from baths operated at 25 to 1000°C. The alloys were much harder than nickel and were superior to nickel coatings in salt spray, atmospheric exposure, and air oxidation tests. Attempts to codeposit the two metals were not successful. (auth)

#### 12903

DIFFUSION BONDING: A NEW WAY TO JOIN CRITICAL PARTS. W. P. McQuillan (Westinghouse Electric Corp., Pittsburgh). *Materials in Design Eng.* 51, No. 4, 14-16 (1960) Apr.

A method is described for joining critical parts by the diffusion of a metal with the base metals. The method can

produce a joint with controlled microstructure closely resembling that of the base metal. The advantages of diffusion bonding over brazing are asserted. The results of tests conducted on Zircaloy-2 tubes bonded to spacers of the same material are discussed. Photomicrographs of chromium, copper, iron, and nickel joints made by diffusion bonding show that only nickel provides bonded microstructure similar to the parent metal, Zircaloy-2. (B.O.G.)

#### 12904

SOME EXPERIENCES WITH REACTIVE METALS MELTED IN HIGH VACUUM. David W. Levinson (Illinois Inst. of Tech., Chicago). p.123-30 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

In the course of alloy development studies concerning  $\text{Cb}$ ,  $\text{Zr}$ , and  $\text{Co}$  alloys were prepared, based on metals of differing origin and purity. Included among these were the aforementioned metals which had been purified by high-vacuum melting. The degree of purification, the effect of source of the base metal concerned, and some properties of the metals and alloys based upon them are discussed. (auth)

#### 12905

THE DEVELOPMENT OF LARGE SCALE ELECTRON BOMBARDMENT MELTING AND ITS EFFECT ON THE COMPOSITION OF METALS AND ALLOYS. Hugh R. Smith, Jr., Charles d'A. Hunt, and Charles W. Hanks (Temescal Metallurgical Corp., Richmond, Calif.). p.131-46 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The effect of electron beam melting on the composition of various reactive metals is significantly different from changes occurring in other types of melting systems. In all operations performed to date, materials processed have been purified to a greater extent than previously was possible; and the physical properties of the purified materials have been improved notably. The degree and mechanism of purification depends on the particular substances subjected to this process. In the case of deoxidation phenomena, an indirect theoretical approach, based on high-temperature gas phase systems involving metals, metal oxides, and oxygen, has provided a surprisingly good basis for estimating deoxidation tendencies of all metals processed so far. (auth)

#### 12906

CASTING OF URANIUM ALLOYS. C. E. Crompton, J. O. Davis, and A. E. Guay (National Lead Co. of Ohio, Cincinnati). p.147-70 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Uranium alloys are of interest as reactor fuels because of physical properties and fabricability. Practical methods are reviewed for producing tonnage quantities of uranium alloyed with molybdenum, columbium, zirconium, and dilute alloys of such elements as silicon, iron, and carbon. Comparative data on grain size and grain refinement by alloying constituents are presented and illustrated by static cast, centrifugally cast, and rolled and heat treated sections. (auth)

#### 12907

ANNEALING OUT OF POINT DEFECTS IN COLD-

WORKED TUNGSTEN. Ronald C. Koo (Westinghouse Electric Corp., Bloomfield, N. J.). p.265-74 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Changes in electrical resistance, measured at liquid nitrogen and liquid helium temperatures, upon annealing cold-worked tungsten were studied. Results led to the proposal that excess vacancies introduced into the metal by cold-work annealed out at  $350^{\circ}\text{C}$  with an activation energy of  $1.7 \pm 0.1$  ev. Isothermal annealing data between  $300$  and  $400^{\circ}\text{C}$  indicated that the process was not unique and was accompanied by other more complex processes. (auth)

#### 12908

FABRICATION OF CRITICAL ASSEMBLY COMPONENTS FROM NON-REACTOR GRADE AND SCRAP ZIRCONIUM AND ZIRCALOY. A. Levy, A. R. Kephart, and C. P. Matuszyk (General Electric Co., Schenectady, N. Y.). p.387-402 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

A group of non-reactor grade ingots and ingots melted entirely from scrap was fabricated into core components for a zero power critical assembly. Problems were resolved relative to the mill fabrication of material with non-uniform composition and hardness. Methods were devised which made possible the suitable and economical working and construction of core components. Data on nuclear, mechanical, and corrosion properties were correlated with ingot composition, hardness, and mill fabrication techniques. (auth)

#### 12909

THE EFFECT OF VARIOUS HEAT TREATING SALTS ON THE HYDROGEN CONTENT OF URANIUM METAL. C. E. Polson, C. F. Hall, and A. E. Guay (National Lead Co. of Ohio, Cincinnati). p.441-63 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The need for control of the hydrogen content of uranium metal that is to be used as a reactor fuel element is described. The relative merits of various salts in both effecting a decrease in the hydrogen pickup and minimizing the corrosion of uranium metal are considered. A large pickup of hydrogen by uranium that was heat treated in a carbonate salt could be partially counteracted by rectification of the carbonate mixture. A chloride salt was shown to be the best in minimizing corrosion and hydrogen pickup. The methods of analyzing for hydrogen in uranium are described. (auth)

#### 12910

FABRICATION AND PROPERTIES OF RHENIUM AND RHENIUM-MOLYBDENUM ALLOY. John H. Port and Joseph M. Pontelandolfo (Chase Brass and Copper Co., Inc., Waterbury, Conn.). p.555-74 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Rhenium is being fabricated on a development scale in the form of strip, small rod, and wire. Powder metallurgy techniques are employed in making the starting pieces. High-purity rhenium powder of controlled particle size and improved processing results in finished forms which have



greater soundness and ductility than material previously described in the literature. Sintering treatments in vacuum and in a hydrogen atmosphere, cold-working procedures, microstructure, and properties are described. (auth)

## 12911

### FABRICATION AND PROPERTIES OF ZIRCALOY TUBE.

A. I. Blank (Chase Brass and Copper Co., Inc., Waterbury, Conn.). p.575-89 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Zircaloy tubes for use in nuclear power reactors are produced by extrusion of billets which have been forged or pre-extruded from ingots. Seizure of Zircaloy to extrusion tools is avoided by encasing billets in a copper jacket with a steel liner. The copper reduces friction and the steel prevents alloying of copper with Zircaloy. This technique makes it possible to extrude at higher temperatures and thus extends the range of extruded size and extrusion ratio for a given press capacity. Tubes are extruded to close dimensional tolerances by careful correlation of tooling and components of billet assembly. The process achieves high product yield and good tool life. The surfaces of large Zircaloy tubes are chemically treated prior to cold drawing to prevent galling. Extrusion data, tensile properties, and work-hardening characteristics of zirconium, Zircaloy-2, and Zircaloy-3 are presented. (auth)

## 12912

BRAZING OF ZIRCALOY. Harry Schwartzbart (Illinois Inst. of Tech., Chicago). p.591-602 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Methods are described for joining Zircaloy to Zircaloy and to stainless steel. The brazing compound consisted of 4 to 5% beryllium with the remainder Zircaloy-2 for both methods. The compound has excellent wettability on Zircaloy and produces strong, tough joints. The joints are resistant to corrosion in water at elevated temperatures. The base metal is not eroded or undercut during brazing. Cracking occurred when heavy walled Zircaloy tubing was brazed to stainless steel, attributed to thermal stresses arising from the difference in thermal coefficients of expansion. (B.O.G.)

## 12913

IMPROVEMENTS IN OR RELATING TO ELECTRO-DEPOSITION OF MAGNESIUM. Allan Robert Gibson (to United Kingdom Atomic Energy Authority). British Patent 831,113. Mar. 23, 1960.

An electrolytic method for plating Mg on U is described. In an example, the U is cleaned in 50%  $H_2SO_4$ , washed and dried in acetone. The U rod is attached to a rotator and immersed in a molten electrolyte of  $MgCl_2$  and KCl in equimolar amounts with 3 to 4% MgS which melts at 489°C. The graphite anodes are arranged about the U cathode, and a current density of 140 to 360 amp/ft<sup>2</sup> is applied while the U rod is rotated. After the proper coating is achieved the rod is removed, cooled, and washed with water. Magnesium anodes may be used. (T.R.H.)

## Properties and Structure

### 12914 A-2249(WEC)

Westinghouse Electric Corp. Aviation Gas Turbine Div., Kansas City, Mo.

DEVELOPMENT OF NIOBIUM BASE ALLOYS. Quarterly Report No. 3 [for] June 15, 1956 to September 15, 1956. R. T. Begley. Oct. 1, 1956. 22p. Contract AF33(616)-3316.

The recrystallization behavior of commercially pure niobium containing various amounts of cold work was investigated by means of hardness measurements and x-ray-diffraction techniques. Niobium with 50% cold reduction was found to recrystallize at approximately 1100°C for one-hour anneal. A number of creep-rupture tests were run on cold-worked niobium in vacuum at 1800°F and reproducible results were achieved. X-ray-diffraction patterns of a number of niobium-rich Nb-Fe and Nb-Cr alloys were obtained. An investigation of the weldability of niobium was initiated. Several welds were made in welding grade argon and in argon contaminated with deliberate additions of nitrogen. Work continued toward solving the difficulties encountered in producing high-purity niobium by vapor deposition of the pentachloride, and on the development of analytical techniques for the analysis of impurities in niobium. (auth)

### 12915 AD-226174

New York. State Univ. Coll. of Ceramics, Alfred. PHASE EQUILIBRIA BETWEEN  $B_2O_3$  AND REFRACTORY OXIDES: THE SYSTEMS  $BeO-B_2O_3$  AND  $ThO_2-B_2O_3$ . Quarterly Progress Report No. 1 [for] June 1, 1959 to August 31, 1959. D. E. Rase. 18p. Contract AF33(616)-6545.

A review of the literature on properties of  $B_2O_3$ ,  $BeO$ , and  $ThO_2$  is summarized. Tentative techniques for the quantitative analysis of  $BeO$  and  $B_2O_3$  in the presence of  $BeO$  and  $ThO_2$  are derived. (C.J.G.)

### 12916 AFOSR-TR-60-26

California. Univ., Berkeley. Minerals Research Lab. DUCTILE CERAMICS. Final Report. E. R. Parker, J. A. Pask, and L. Himmel. Feb. 1960. 10p. Contract AF49(638)-56.

A fundamental study of the mechanical behavior of ceramic materials is reported. The main objective of this study was to establish the basic reasons for the brittleness generally associated with such materials. Efforts were made to determine whether or not ceramic materials are inherently brittle and if not, whether a sufficient amount of plasticity could be imparted to such normally brittle solids to make them useful for structural engineering applications. (W.L.H.)

### 12917 APEX-300(Del.)

Denver. Univ. Denver Research Inst. FUNDAMENTAL ALLOY DEVELOPMENT STUDIES. Quarterly Progress Report No. 5 [for] November 1, 1956 to January 31, 1957. Charles E. Lundin and Donald T. Klodt. Feb. 15, 1957. Decl. with deletions Nov. 4, 1959. 39p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Subcontract AT-33. OTS.

The equilibrium isothermal anneals of the binary system, Y-Zr, in the solid-state region, as well as incipient melting treatments, were completed. Microscopic examinations of all of the specimens were completed, the phase relationships noted, and the final equilibrium phase diagram for the system presented. Theoretical considerations of the alloying behavior of Ce, Ti, and Cr with Y are presented, and some of the possible types of binary phase diagrams which can be expected are given. A metallographic study of the Y-H system was undertaken to check the solubility boundaries obtained from the pressure-temperature-composition data. Hydride specimens were produced at four temperature levels, 1112, 1472, 1832, and 2192°F.

Compositions of H varied from the single-phase Y solid solution region to the two-phase region and into the single-phase hydride region. Metallographically, the phase relationships in the specimens examined correlated very well with the solubility boundaries determined from thermodynamic data. Photomicrographs of structures in the Y-H system are presented. (auth)

#### 12918 APEX-334(Del.)

Denver. Univ. Denver Research Inst.  
FUNDAMENTAL ALLOY DEVELOPMENT STUDIES.  
Quarterly Progress Report No. 7 [for] May 1, 1957 to July 31, 1957. Charles E. Lundin and Donald T. Klodt. Aug. 1, 1957. Decl. with deletions Nov. 4, 1959. 28p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Subcontract AT-33. OTS.

As-cast surveys of the binary systems of Y-Ti and Y-Cr were completed, and isothermal annealing treatments to investigate the solid-state phase fields were started. Tentative phase diagrams are presented; both alloy systems exhibited a single eutectic with no intermediate phases and very restricted primary solid solubilities. A preliminary as-cast survey of the binary system, Ce-Y, was started from 0 to 100 wt.% Ce by 10 wt.% increments. Very extensive solid solubility of Ce in Y was indicated. The hydriding of Y was continued at low temperatures (from 932 to 68°F). A YH<sub>3</sub> phase was found to form below 581°F and to be stable at atmospheric pressure. Its formation from YH<sub>2</sub> was very rapid, complete, and occurred at a specific temperature level. Reversibility of the reaction occurred repeatedly on lowering and raising the temperature. (auth)

#### 12919 APEX-349(Del.)

Denver. Univ. Denver Research Inst.  
FUNDAMENTAL ALLOY DEVELOPMENT STUDIES.  
Quarterly Progress Report No. 8 [for] August 1, 1957–October 31, 1957. Charles E. Lundin and Donald T. Klodt. Nov. 15, 1957. Decl. with deletions Nov. 4, 1959. 34p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Subcontract AT-33. OTS.

Equilibrium isothermal anneals of the systems Y-Cr and Y-Ti to fix the final position of the solid-state solubility boundaries are nearly complete. The Y-Ce system was subjected to a considerable as-cast survey. Tentative diagrams are presented for the systems, Y-Cr and Y-Ti. Investigation of the low-temperature region of the Y-H system was continued. Further characteristics of the formation and decomposition of the YH<sub>3</sub> phase were observed. A temperature hysteresis of the formation and decomposition of YH<sub>3</sub> in the YH<sub>2</sub>-YH<sub>3</sub> region was indicated. The characteristics of nitriding of Y metal were studied. Diffusion of N into massive specimens of metal was very slow and was impeded by the formation of a surface nitride layer. X-ray-diffraction patterns of Y, YN, YH<sub>2</sub>, and YH<sub>3</sub> are presented and some structures, lattice parameters, and x-ray densities were determined. (auth)

#### 12920 APEX-360(Del.)

Denver. Univ. Denver Research Inst.  
FUNDAMENTAL ALLOY DEVELOPMENT STUDIES.  
Quarterly Progress Report No. 9 [for] November 1, 1957 to January 31, 1958. Charles E. Lundin, Donald T. Klodt, Richard D. Seibel, and Morris M. Mote. Feb. 20, 1958. Decl. with deletions Nov. 4, 1959. 65p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Subcontract AT-33. OTS.

Theoretical considerations and equipment design studies were made to initiate a program requiring the determination of rates of permeability of hydrogen through various metallic materials. The final equilibrium phase diagrams

of the binary systems, Y-Cr and Y-Ti, are presented. A eutectic was found in the Y-Ti system at 12 wt.% titanium at a temperature of 2525°F. The investigation of the effects of N dissolved in Y on hydriding characteristics was continued. Methods of preparing dilute N alloys were developed. Nominal compositions of dilute alloys of N in Y were prepared at 0.3, 0.6, 0.9, and 1.2 wt.% N levels. Hydriding absorptive and retentive capacity of these alloys are being determined. An x-ray-diffraction survey of samples throughout the Y-H system was made to analyze the structures present. The structures were found to correlate with the phase diagram developed from the pressure-temperature-composition data very well. An x-ray structure determination was made of the YH<sub>3</sub> phase. The structure is hexagonal close-packed and density is 3.958 gm/cc. (auth)

#### 12921 APEX-423(Del.)

Titanium Alloy Mfg. Div., National Lead Co., Niagara Falls, N. Y.

COMPONENT DEVELOPMENT. Progress Report No. 4. J. D. Roach. May 21, 1958. Decl. with deletions Nov. 4, 1959. 18p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Contracts AF33(600)-38062 and AT(11-1)-171. Subcontract AT-93. OTS.

The equilibrium H content of Y under 1 atmosphere H pressure, in the temperature range 700 to 1750°F, was unaffected by temperature and corresponded to the compound YH<sub>2</sub>. Above 1750°F, the equilibrium H content decreased with increasing temperature to 1.4 wt.% H at 2250°F since a two phase structure, Y plus YH<sub>2</sub>, exists at the higher temperatures. As the temperature was decreased below 700°F, under 1 atmosphere pressure, the equilibrium H content of Y increased to approximately 2.6 wt.% and a new phase was formed. Based on the H content, this phase would be Y<sub>3</sub>H<sub>7</sub>, but positive identification was not obtained. Decreasing the pressure to 0.15 atmos did not significantly affect the equilibrium H content of Y in the temperature range 1200 to 1750°F. It was effective in decreasing the rate of hydriding. The powder formation and cracking of hydrided Y which occurs on standing in air was found to be due to a reaction between the thin nitride film formed on the surface of the material during the hydriding treatment and water vapor. The reaction products were yttrium oxide and ammonia. The presence of Y metal phase in material hydrided above 1850°F increased the hot ductility of hydrided Y. Hot forging tests revealed that Y containing 1.8 wt.% H could be deformed at 1800°F. In an Ar atmosphere, YH<sub>2</sub> was stable up to at least 1750°F. (auth)

#### 12922 APEX-424(Del.)

Denver. Univ. Denver Research Inst.  
FUNDAMENTAL ALLOY DEVELOPMENT STUDIES.  
Quarterly Progress Report No. 4 [for] May 1, 1958 to July 31, 1958. Charles E. Lundin, Donald T. Klodt, Richard D. Seibel, and Morris W. Mote. Aug. 20, 1958. Decl. with deletions Nov. 4, 1959. 94p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Contracts AF33(600)-38062 and AT(11-1)-171. Subcontract AT-33. OTS.

Data are presented on the rates of hydrogen permeation at various temperatures and pressure differentials for the following materials: 447 stainless steel, 446 stainless steel, 310 stainless steel, and 70% iron-25% chromium-5% aluminum alloy. The permeability data were assessed in terms of the Richardson permeability equation for validity with the theoretical relationships. A good agreement was obtained. A determination of the phase diagram of the yttrium-hafnium alloy system was continued. The as-cast



survey of the yttrium-vanadium system was completed. A tentative, partial phase diagram of the Y-C alloy system is presented from the completed as-cast survey and a few preliminary isothermal anneals. Examination of the alloys of the as-cast survey of the Y-Nb system was completed. The studies of the binary Y-Mo alloy system were started with a complete as-cast survey. The Y-Al phase diagram is presented in tentative form as derived from examination of the as-cast alloys. A series of intermediate phases were located. The Y-Si phase diagram is presented in tentative form as derived from examination of the as-cast alloys. A series of intermediate phases were located. (auth)

**12923** APEX-449(Del.)

Denver. Univ. Denver Research Inst.

FUNDAMENTAL ALLOY DEVELOPMENT STUDIES.

Quarterly Progress Report No. 10 [for] February 1, 1958 to April 30, 1958. Charles E. Lundin, Donald T. Klodt, Richard D. Seibel, and Morris M. Mote. May 20, 1958. Decl. with deletions Nov. 4, 1959. 52p. For General Electric Co. Aircraft Nuclear Propulsion Dept. Contracts AF33(600)-38062 and AT(11-1)-171. Subcontract AT-33. OTS.

The equipment required to study the rates of permeability of hydrogen through various metallic materials of interest was assembled, calibrated, and placed in operation. Data on the rates of permeation of a 447-type stainless steel are reported at 1400 to 2000°F, and for a series of pressure differentials. The as-cast survey of the yttrium-vanadium phase diagram was completed. No intermediate phases were found. A eutectic was found at 7 wt.% V and at a temperature of 2615°F. A liquid-immiscibility gap was present between about 9 and 99 wt.% V. The monotectic was located at approximately 99 wt.% V and at a temperature of about 3452°F. The maximum solubility of V in Y was approximately 0.5 wt.% V. A tentative diagram is presented. The as-cast survey of the Y-Hf phase diagram was completed. A eutectic was located at 23 wt.% Hf at a temperature of 2596°F. No intermediate phases were present. The as-cast survey indicated a solubility of Y in Hf of about 2 wt.% and of Hf in Y of about 4 wt.%. A tentative diagram is presented. The Y-Nb phase diagram was outlined as to its features. The system did not have any intermediate phases. A liquid-immiscibility gap was indicated in the region of 60 to 90 wt.% Nb. A eutectic was found at 6 wt.% Nb at a temperature of 2683°F. The Y-Al phase diagram was outlined from an as-cast survey. A series of intermediate phases was located. Two eutectics were located at 9 and 90 wt.% Al. Terminal solid solubilities appear to be less than 1% from examination of the as-cast structures. The Y-Si phase diagram was outlined from an as-cast survey. A series of intermediate phases was located. Investigation of the effects of N dissolved in Y was continued. Cold workability and air oxidation studies of dilute nitrated Y exhibited very good characteristics. An x-ray diffraction study of the H-saturated Y solid solution produced lattice parameters and an x-ray density as follows:  $a_0 = 3.665\text{\AA}$ ,  $c_0 = 5.801\text{\AA}$ , and  $\rho = 4.377\text{ gm/cc}$ . (auth)

**12924** ARF-6038-8

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

MODIFIED-GRAPHITE TECHNOLOGY. Quarterly Report No. 1. S. W. Bradstreet. Jan. 20, 1960. 58p. Contract AT(33-3)-4. (LAR-20). OTS.

The past year of study of fine, molded, multicrystalline graphites with particular reference to the interrelation among certain properties with the composition, fabricating

techniques, and thermal treatments found to influence them are summarized. Within the limitations of the compositions and specimen size studied, conclusions have been drawn regarding the relation of these properties (density, volume electrical resistance, flexural modulus, thermal expansion coefficient, and flexural and tensile strength) to the rheology, gas permeability, and structure of the molded body. The best conformity of all specimens to a given mean is obtained when a thermoplastic binder-deficient mix is vacuum molded at an elevated temperature, carbonized slowly in an inert gas purge, and graphitized together. The internal error of a 30-specimen block is then found to be approximately four percent plus the error of the property measurement. Binder-rich mixes are more sensitive to treatment variations, but the desirable rheology of a binder-rich mix can be simulated without this variability by substituting moderate proportions of a thermal carbon for some of the coke flour. The theoretical promise of furfuryl alcohol as a binder has been experimentally confirmed. Unusual care is required in low-permeability mixes, to prevent rupture during baking. To an as yet undefined extent, this may be avoided by modifying the thermosetting FA binder with the thermoplastic coal tar pitch. (auth)

**12925** CF-57-3-92

Oak Ridge National Lab., Tenn.

BERYLLIUM. M. J. Whitman. Mar. 21, 1957. Decl. Aug. 14, 1959. 25p. Contract [W-7405-eng-26]. OTS.

The creep-rupture data in the literature were obtained from vacuum cast and extruded Be, rather than from the hot-pressed Be. A research program is being conducted which will eventually provide the design engineers with data on the high-temperature strength properties of hot-pressed Be. In the interim, it will be necessary for the metallurgists and design engineers to make judicious estimates and extrapolations from the data available. The data available, as of June 1955, concerning the performance of Be at elevated temperatures have been assembled. Information on the resistance of Be to corrosion by Na under conditions incorporating stress, as well as the compatibility of Be, Na, and Inconel are included. (auth)

**12926** DMIC-Memo-46

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

FATIGUE DATA ON PRECIPITATION-HARDENABLE STAINLESS STEELS. R. J. Favor, H. J. Grover, and W. P. Achbach. Mar. 11, 1960. 18p. (PB-161196). OTS.

Fatigue data on precipitation-hardenable stainless steels such as 17-7 PH and AM 350 and 355 are presented. (J.R.D.)

**12927** DMIC-Memo-50

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

DIFFUSION RATES AND SOLUBILITIES OF INTERSTITIALS IN REFRACTORY METALS. W. D. Klopp and Vincent D. Barth. Apr. 4, 1960. 10p. (PB-161200). OTS.

Diffusion data for oxygen, nitrogen, carbon, and hydrogen in niobium and tantalum are presented. Other data on the solubility limits of carbon, nitrogen, oxygen, and hydrogen in tungsten, tantalum, molybdenum, niobium, vanadium, and chromium at 600 to 1200°C are also included. Mathematical relations and expressions concerning diffusion are discussed. 45 references. (J.R.D.)

**12928** HW-33024

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A SONIC TEST FOR PREFERRED ORIENTATION IN HANFORD FUEL ELEMENT CORES. A. A. Ferguson and E. C. Wood. Jan. 11, 1955. Decl. Dec. 3, 1959. 22p. Contract W-31-109-eng-52. OTS.

A technique is described whereby preferred orientation in uranium fuel cores can be determined rapidly and non-destructively by measuring the resonant frequency of the core in the longitudinal and torsional modes. A good correlation is obtained with x-ray-diffraction techniques and a tentative theory is proposed. Details of the apparatus and techniques used are included. (auth)

**12929** HW-61757(Rev.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

EVALUATION OF ALUMINUM FOR USE IN REACTORS COOLED BY HIGH-TEMPERATURE RECIRCULATING WATER. J. A. Ayres. Feb. 10, 1960. 25p. Contract AT(45-1)-1350. OTS.

Information for use in evaluation of aluminum for water-cooled reactor applications is presented. Discussions of the corrosion and strength aspects of aluminum alloys, descriptions of special operational problems, and suggested programs for immediate and long-range development studies are included. Aluminum appears potentially suitable as cladding for fuel elements in reactors cooled by high-temperature recirculating water, however there are several areas in which more information must be obtained before a realistic evaluation can be made. (auth)

**12930** JPL-PR-30-20

California Inst. of Tech., Pasadena. Jet Propulsion Lab. THE THERMAL EXPANSION OF SYNTHETIC GRAPHITES AT TEMPERATURE INTERVALS BETWEEN 80 AND 2000°F. Robert D. Allen. Nov. 30, 1959. 21p. Contract NASw-6.

The mean linear and cubical coefficients of thermal expansion of eight commercial samples of graphite were determined for temperature intervals between 80 and 2000°F. The linear thermal expansion was measured with an automatic recording dilatometer using a rod-shaped specimen 2 in. long and  $\frac{1}{4}$  in. across. The specimen was heated in an atmosphere of helium. The results were in good agreement with those of Currie, Hamister, and MacPherson. The mean linear coefficient was found to increase with temperature. For the samples studied, the mean linear coefficients from 80 to 2000°F were  $1.50$  to  $2.34 \times 10^{-6}/^\circ\text{F}$  parallel and  $2.26$  to  $3.45 \times 10^{-6}/^\circ\text{F}$  perpendicular to the grain and were found to vary linearly with the electrical resistivity measured at 32°F. (auth)

**12931** KAPL-1590

Knolls Atomic Power Lab., Schenectady, N. Y. MECHANICAL PROPERTIES OF STAINLESS STEEL- $\text{UO}_2$  DISPERSION FUEL ELEMENTS. W. D. Valovage and R. A. Siergiej. July 7, 1959. 18p. Contract W-31-109-Eng-52. OTS.

Mechanical properties of stainless steel- $\text{UO}_2$  dispersion fuel elements were determined on specimens fabricated (a) by the cold-binder extrusion and hot swaging technique, (b) by the single hot-coextrusion method, and (c) by the hot-coextrusion method followed by a second hot-extrusion, hot-rolling, swaging, or drawing. Tensile test results show that cold-binder material has very good tensile properties with the exception of ductility. Bend tests show that coarse oxide material has better ductility than the fine oxide both before and after irradiation. Although the fuel element material is low in ductility, test results indicate that completed fuel elements composed of a dispersion of  $\text{UO}_2$  clad

in stainless steel have fair mechanical properties for reactor use even after high burnups. (auth)

**12932** KAPL-M-APB-2

Knolls Atomic Power Lab., Schenectady, N. Y. EFFECT OF OXYGEN ON THERMAL STABILITY OF 22% URANIUM-ZIRCONIUM ALLOY. A. P. Beard. Aug. 1954. Decl. Feb. 4, 1960. 3p. Contract W-31-109-Eng-52. OTS.

Vacuum heat treatment at 800°C for 35 hr appears to help stabilize 22% U-Zr alloys prepared from arc-melted material. With 100 cycles the percentage change was +0.12. An alloy to which 0.3 wt.%  $\text{O}_2$  was added (based on Zr content) changed length +0.06% in 100 cycles. (J.R.D.)

**12933** LS-59

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON GRAIN-SIZE IN URANIUM. July 1959. 15p.

A bibliography is presented on grain size in U. The references were collected from Nuclear Science Abstracts, Vols. 1-12 and Vol. 13, Nos. 1-9 (1948-1959), and reports in the Israel Atomic Energy Commission Library. 173 references. (T.R.H.)

**12934** LS-60

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON GAMMA TO BETA AND BETA TO ALPHA PHASE TRANSFORMATIONS IN URANIUM. July 1959. 4p.

A bibliography is presented on  $\gamma$ - $\beta$  and  $\beta$ - $\alpha$  phase transformations in U, with references collected from Nuclear Science Abstracts, Vols. 1-12 and Vol. 13, Nos. 1-9. 27 references. (T.R.H.)

**12935** LS-63

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON DIFFUSION OF U/Al, U/Ni, Ni/Al, U/Ni/Al (SOLID STATE BONDING; PRESSURE BONDING). Aug. 1959. 7p.

A bibliography is presented on diffusion in the couples U/Al, U/Ni, Ni/Al, and U/Ni/Al including solid-state bonding and pressure bonding. The sources of information were Nuclear Science Abstracts Vols. 4-12, 1950-58, and Vol. 13, Nos. 1-10, Chemical Abstracts Vols. 50-52, 1956-1958, Vol. 53, Nos. 1-11, Metallurgical Abstracts Vols. 19-25, Sept. 1951-Aug. 1958, Vol. 26 up to July 1959, and reports in the Israel Atomic Energy Commission Library. 54 references. (T.R.H.)

**12936** MRC-R156

Materials Research Corp., Yonkers, N. Y. PERMEABILITY OF CLADDING MATERIALS TO INERT GASES. Progress Report No. 15 [for] Period March 15, 1960 to April 15, 1960. G. T. Murray and G. Pincus. Apr. 22, 1960. 6p. Contract AT(30-1)-2286. OTS.

A 0.042 in. thickness specimen of aluminum was given successive diffusion anneals at 575°C for one and two hour periods. Nearly all of the gas escaped during the first hour. Results indicate some loss of helium from the weld interface also. Two other sandwich specimens of 0.018 and 0.008 in. thickness were given successive diffusion anneals of 5 hours duration at 475°C. Nearly all of the helium escaped during the first 5-hour period. No bubbles were found in these samples by microscopic examination and it was concluded that either bubbles do not form in the sandwich type specimens or that they are not visible at 2000 $\times$  magnification. Tests of neutron irradiated aluminum revealed that  $5.8 \times 10^{14}$  atoms of helium were released from a sample which was annealed at 595°C for 94 hr. The sample



was found to contain a total of  $2.4 \times 10^{16}$  atoms; from these data a diffusivity value of  $2.4 \times 10^{-10}$  cm<sup>2</sup>/sec<sup>-1</sup> was computed. Such a low diffusivity is considered unlikely at 575°C and metallographic examination confirmed this by revealing the formation of bubbles located primarily at subgrain boundaries. (For preceding period see TID-5622.) (J.R.D.)

#### 12937 NAA-SR-4646

Atomics International Div., North American Aviation, Inc.,  
Canoga Park, Calif.

#### SOME PROPERTIES OF URANIUM-MOLYBDENUM ALLOY FUELS FOR ORGANIC MODERATED REACTORS.

W. H. Friske. Apr. 1, 1960. 26p. Contract AT-11-1-GEN-8. OTS.

The mechanical and metallurgical properties of six low-alloy uranium alloys were investigated. The alloy addition of 3.5 wt.% molybdenum to uranium increased stability during thermal cycling and creep strength at 900°F. The addition of 0.1% aluminum to the U-3.5 Mo binary alloy further increased both creep and tensile properties at 900°F. A U-2 Zr-0.1 Al alloy exhibited poor dimensional and geometric stability during thermal cycling. Irradiation tests to date have indicated that U-3.5 Mo and U-3.5 Mo-0.5 Si alloys will be dimensionally stable at a peak burnup of 3000 Mwd/MTU. (auth)

#### 12938 NAA-SR-Memo-4836

Atomics International Div., North American Aviation, Inc.,  
Canoga Park, Calif.

#### EVALUATION OF APM M-486 WELDED SHEET. B. N. Briggs. Dec. 30, 1959. 5p. OTS.

Effects of welding on aluminum powder metallurgy alloy M-486 (7.8% Fe; 0.2% each V, Cr, Zr, and Ti) sheet were investigated. The weld pieces exhibited, at room temperature and 700°F, a strength of  $\frac{1}{3}$  and  $\frac{1}{4}$  that of 5052-H38 Al sheet material at the respective temperatures. (J.R.D.)

#### 12939 NMI-9801

Nuclear Metals, Inc., Concord, Mass.

STUDY OF GASES IN METALS. Quarterly Report No. 1 to Wright Air Development Center. J. P. Pemsler. Oct. 22, 1959. 12p. Contract AF33(616)-6627.

The structure and phase diagrams, thermodynamic data, disposition of gases in the metals and effect of dissolved gases on physical properties, gas removal by vacuum annealing, and selected oxidation-reduction reactions for niobium and tantalum are reported. (W.L.H.)

#### 12940 NRL-5461

Naval Research Lab., Washington, D. C.

DIFFUSION OF Nb WITH Cr, Fe, Ni, Mo, AND STAINLESS STEEL. L. S. Birks and R. E. Seebold. Feb. 2, 1960. 13p.

Diffusion couples were prepared at about 1100°C from pure Nb and several compositions of stainless steel and also with each of the components of the steel, namely, Cr, Fe, Ni, and Mo. Using the electron probe microanalyzer to measure the composition across these diffusion zones, intermediate phases of stoichiometric composition were found for each of the binaries. In Nb-Cr diffusion the phases NbCr<sub>2</sub> and NbCr<sub>7</sub> were always present, and after long heating times NbCr<sub>7</sub> plus excess Nb in solid solution was observed as well. In Nb-Fe diffusion the intermediate phase was NbFe<sub>2</sub> plus excess Fe in solid solution, but there were isolated Nb-rich compounds far out into the iron, depending on the impurity composition of the iron. Nb-Ni couples often melted near 1100°C, although the eutectic composition is given as 1175°C in some of the literature. Below 1095°C NbNi plus excess Nb in solid solution was

observed and Nb<sub>2</sub>Ni precipitated in the NbNi matrix on cooling. Above 1195°C, at near melting, rapid diffusion led to zones as long as 1400 microns with NbNi<sub>3</sub> precipitating in an NbNi matrix on cooling. Nb and Mo were miscible at all compositions, and the diffusion coefficient ranged from  $3$  to  $8 \times 10^{-11}$  cm<sup>2</sup>/sec. Diffusing Nb with stainless steel showed a main zone of about 40% Nb, 40% Fe, 8% Cr, and 5% Ni (all as weight per cent) and was speculated to contain a mixture of NbFe<sub>2</sub>, NbCr<sub>2</sub>, and NbNi. A small region near the Nb side of the diffusion zone was speculated to contain a mixture of NbFe<sub>2</sub>, NbCr, and Nb<sub>2</sub>Ni. (auth)

#### 12941 TID-5722

Stanford Research Inst., Menlo Park, Calif.

THERMAL EXPANSION OF URANIUM DIOXIDE. Final Report. F. A. Halden, H. C. Wohlers, and R. H. Reinhart. Apr. 15, 1959. 24p. SRI Project No. SU-2542. Contract AT(04-3)-115. OTS.

The thermal expansions of commercial uranium dioxide specimens were measured up to the melting point. The linear expansion of dense, normal grain size UO<sub>2</sub> follows closely the equation:  $L = L_0(1 + 6.0 \times 10^{-6}t + 2.0 \times 10^{-9}t^2 + 1.7 \times 10^{-12}t^3)$ . An anomalous expansion was noted in the temperature range 1000 to 1500°C. Above 2500°C the rapid vaporization and crystal growth of UO<sub>2</sub> necessitate the application of heating techniques which provide rapid heating and quenching in order to obtain reliable data. The use of solar and arc-melting furnaces for this type of measurement is described. (auth)

#### 12942 TID-5749

Bureau of Mines, Pittsburgh.

ZIRCONIUM HAZARDS RESEARCH. Summary Report No. 3692. J. A. Herickes, P. A. Richardson, M. Weiss, and G. Gelernter. June 30, 1958. 31p. Contract AT(11-1)-473. OTS.

Pyrophoric coatings on two varieties of zirconium wire were obtained by exposing the metal to gaseous atmospheres of air, oxygen, and steam under various conditions of temperature and pressure. Under certain experimental conditions, pretreatment of zirconium foil in nitrogen, hydrogen, or carbon dioxide embrittled the specimens. Subsequent treatment with steam at 500°C generally resulted in fragmentation of the samples; in some cases the reaction was so violent that the fragments were splattered over the reaction tube. The study of the sensitivity characteristics of zirconium samples such as sponge, scrap, foil and powder was continued. Induced mechanical stresses did not materially affect the minimum fragmentation energy of two types of zirconium wire tested. The minimum fragmentation energy for 62-mil Zircaloy wire was found to be much higher than that obtained for the Zircaloy scrap. (auth)

#### 12943 TID-5768

Denver. Univ. Denver Research Inst.

THE DETERMINATION OF THE EQUILIBRIUM PHASE DIAGRAM, ZIRCONIUM-NIOBIUM. Period covered: March 1, 1960 to April 1, 1960. Charles E. Lundin. Apr. 15, 1960. 6p. Contract AT(11-1)-752. OTS.

Hardness data were gathered for Zr-Nb alloys annealed at 600 to 1000°C for various periods, over the entire composition range. The data for 600, 640, 700, and 900°C plotted against composition are included and show that hardness reaches a maximum with about 9 wt.% Nb for anneals above 620°C, whereas anneals below this temperature show no peak. The microstructure of the alloys was also examined, and those annealed above 600°C exhibited transformation ( $\beta \rightarrow \alpha$ Zr) products, while the 600°C alloy showed none. This in conjunction with the hardness data

would indicate an invariant transformation temperature between 600 and 620°C. (D.L.C.)

#### 12944 UCRL-5801

California. Univ., Livermore. Lawrence Radiation Lab. INTERMETALLIC COMPOUNDS BETWEEN LITHIUM AND LEAD. V. BRILLOUIN POLYHEDRA OF THE VARIOUS PHASES. William J. Ramsey and James O. Jepson. Nov. 13, 1959. 16p. Contract W-7405-eng-48. OTS.

Brillouin polyhedra for the intermetallic compounds of lithium and lead were determined using the zone theory. From these determinations, predictions and explanations of some electromagnetic and structural properties of the intermetallic compounds were made. (For Part IV see UCRL-4973.) (C.J.G.)

#### 12945 WAL-TR-405.2/4

Watertown Arsenal Lab., Mass.

THE TRUE-STRESS TRUE-STRAIN PROPERTIES OF TITANIUM AND TITANIUM ALLOYS AS A FUNCTION OF TEMPERATURE AND STRAIN RATE. Thomas S. DeSisto. Mar. 1960. 45p. DA Project 5B93-32-003. OTS.

An experimental investigation was conducted on the plastic flow and fracture characteristics of titanium and titanium alloys as a function of strain rate and temperature. The results show that, for all materials tested, the flow stress increases with decreasing temperature and increasing strain rate, and the strain at fracture decreases with decreasing temperatures. The strain at maximum load decreases with increasing strain rate and decreasing temperature. An exception is shown by the commercially pure titanium where the strain at maximum load and fracture strain increase sharply with decreasing temperature. (auth)

#### 12946 WCAP-1513

Westinghouse Electric Corp. Atomic Power Dept. Pittsburgh.

THERMOELECTRIC NUCLEAR FUEL ELEMENT PROGRESS REPORT NO. 20 FOR FEBRUARY 1960. G. R. Kilp, W. P. Blankenship, P. V. Mitchell, and S. W. Sandberg. Mar. 10, 1960. 15p. Contract AT(30-3)-500. OTS.

Thermoelectric measurements were made on  $USe_x$ ,  $UTe_x$ , and  $US_x$ , n-p junctions of  $PbTe$  and  $Bi_{0.05}Ge_{0.95}Te$ , and swaged elements. Mild steel and electrolytic iron exhibited best results to date for end caps. Results for an in-pile device consisting of a swaged couple of n-type  $PbTe$  and p-type  $Bi_{0.1}Ge_{0.9}Te$  with a rod heater at the center are reported. The thermal conductivity and Seebeck coefficient remained stable while the resistivity increased. The irradiation of  $Li_{0.08}Ni_{0.92}O$  at 400°C and p-type  $PbTe$  at 375°C produced little change in their properties. (For previous period see WCAP-1380.) (C.J.G.)

#### 12947 AEC-tr-4049

INORGANIC CHEMISTRY—EXISTENCE OF CONTINUOUS TRANSITION OF QUADRATIC STRUCTURE TO CUBIC IN RARE EARTH ZIRCONIA-OXIDE SYSTEMS. Jean Lefevre, Robert Collongues, and Monique Perez y Jorba. Translated by Lydia Venters (Argonne National Lab.) from *Compt. rend.* 249, 2329-31 (1959). 6p. JCL.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, as abstract No. 4516.

#### 12948 NP-tr-412

[France. Commissariat à l'Énergie Atomique, Paris]. DEVELOPMENT AND EXAMINATION OF THE MICROGRAPHIC STRUCTURES OF ALLOYS OF URANIUM CONTAINING 0.5 TO 10 WEIGHT PER CENT OF MOLYBDENUM. J. Laniesse and M. Bouleau. Translated by M. H. Rand (U.K.A.E.A. Atomic Energy Research Estab-

lishment) from CEA-Note-269. 19p. (Handwritten MS. copy). (JCL).

A review of preparation methods for examination of the micrographic structures in uranium alloys containing 5 to 10% molybdenum is presented. Polishing and etching methods for rough cast alloys are outlined, and information related to the various phases and their characteristics is included. (J.R.D.)

#### 12949

TWINNING CAUSED BY ABRASION ON SINGLE CRYSTALS OF BERYLLIUM. V. D. Scott (Imperial Coll. of Science and Tech., London). *Acta Cryst.* 13, 313-19 (1960) Apr. 10. (In English)

Results concerning the lattice re-orientation caused by abrasion on single crystals of beryllium have been obtained by electron diffraction. The occurrence of twinning found in certain cases in sub-surface regions of abraded single-crystal beryllium surfaces was dependent upon the initial crystal orientation with relation to the direction of the applied compressive stresses. The operative  $\{10\bar{1}2\}$  set of twinning planes was found to be the one which most facilitated development of the characteristic oblique  $[001]$  compression fibre texture produced by the abrasion in the outermost surface layers by rotational slip or flexural rotational slip of the sub-surface twin. (auth)

#### 12950

RELATIVE ENERGIES OF TILT-TYPE SUBBOUNDARIES IN ALUMINUM. K. T. Aust (General Electric Research Lab., Schenectady, N. Y.). *Can. J. Phys.* 38, 547-54 (1960) Apr.

The relative energies of subboundaries in aluminum bicrystals having two different effective impurity concentrations were obtained in terms of a reference large-angle grain boundary. The data for subboundary energy versus subgrain orientation difference ( $\theta$ ) showed a cusp at  $\theta \approx 0.75^\circ$ . The existence of such a cusp was previously predicted by Martius and Chalmers from considerations of impurity effects at boundaries. (auth)

#### 12951

RELATIONS BETWEEN THE RESTORATION OF MECHANICAL PROPERTIES AND ELECTRIC RESISTIVITY AND THE EVOLUTION OF STRUCTURE OBSERVED IN ALUMINUM WITH AN ELECTRON MICROSCOPE. Christian Messenger and Omourtague Dimitrov (Centre National de la Recherche Scientifique, [Paris]). *Compt. rend.* 250, 1847-9 (1960) Mar. 7. (In French)

In order to study the effect of structural evolution on the mechanical properties of aluminum, microhardness tests were made on a series of refined aluminum samples with impurities of the order of  $90 \times 10^{-6}$ . The evolution of microhardness of cold-worked and recrystallized Al showed that restoration is produced in two steps—the first corresponds to the perfecting in small blocks in the cold-worked structure and the second to the growth of these blocks. The effect of the addition of Cu to the aluminum was investigated by measurement of the electrical resistivity and break point. The results showed that the impurities exercise a more retarding effect on the growth of the zones than on the perfecting. (J.S.R.)

#### 12952

EFFECT OF A HEATING PRELIMINARY TO ROLLING ON THE EVOLUTION OF THE STRUCTURE AND OF THE PROPERTIES OF PLATES OF INDUSTRIAL ALUMINUM-MANGANESE ALLOYS SOLIDIFIED SEMI-CONTINUOUSLY. Jean Hérenghuel, Pierre Lelong, and Jacques Moisan. *Compt. rend.* 250, 2200-2 (1960) Mar. 21. (In French)



Extended heating applied before rolling of solidified Al-Mn alloys is called improperly "homogenization." It causes, actually, a precipitation in the tempered solid solution and, at high temperature, a coalescence of the phases out of solution. This structural modification inhibits the growth of the grain and regularizes the aspect after anodic oxidation. (tr-auth)

## 12953

THE EFFECTS OF INDIRECT INTERACTIONS IN THE MAGNETIC THEORY OF TRANSITION METALS AND RARE EARTHS. I. FERROMAGNETISM. A. A. Berdyshev and B. V. Karpenko (Gor'kiĭ Ural State Univ., USSR). *Fiz. Metal. i Metalloved.* **8**, 330-36(1959) Sept. (In Russian)

The second approximation in the perturbation theory of transition metal exchange models indicates indirect interactions between d-electrons. Considering this interaction, ferromagnetism becomes possible in the absence of direct bonds or even with negative integral d-d exchange. The effects of indirect interactions on spontaneous magnetization are analyzed. (tr-auth)

## 12954

HALL'S EFFECT IN IRON-NICKEL ALLOYS NEAR CURIE TEMPERATURE. N. V. Bazhanova (Moscow Inst. of Railroad Transportation). *Fiz. Metal. i Metalloved.* **8**, 342-5(1959) Sept. (In Russian)

Magnetic properties and Hall's electromotive forces were measured for specimens of the following compositions in wt.-%: 30.5 Ni-69.5 Fe; 32 Ni-68 Fe; 34.7 Ni-65.3 Fe; 37 Ni-63 Fe; 38 Ni-62 Fe; and 40 Ni-60 Fe. (R.V.J.)

## 12955

SELF-DIFFUSION OF ZIRCONIUM AND ZIRCONIUM ALLOYS WITH TIN. V. S. Lyashenko, V. N. Bykov, and L. V. Pavlenov. *Fiz. Metal. i Metalloved.* **8**, 362-9(1959) Sept. (In Russian)

Zr<sup>85</sup> was used in the investigation of  $\alpha$ - and  $\beta$ -zirconium self-diffusion. The self-diffusion activation energy was 52,000 and 38,000 cal/g at., respectively. The self-diffusion activation energy of  $\alpha$ -zirconium was increased by alloying with tin; maximum activation energy (75,000 cal/g at.) was reached with 2.39 at.% Sn. (R.V.J.)

## 12956

HYDROGEN EFFECT ON VT-8 ALLOY WITH STRONG CREEP. I. I. Kornilov, C. G. Galzunov, and A. M. Yakimova. *Fiz. Metal. i Metalloved.* **8**, 370-77(1959) Sept. (In Russian)

The influence of hydrogen and oxygen on the structure and mechanical properties of Al-Mo-Ti alloy (VT-8 alloy) is described. (tr-auth)

## 12957

STRUCTURAL CHANGES AND ABNORMAL DEPENDENCE OF Ni-Fe (50% Ni) ALLOY MAGNETIC PROPERTIES ON TEMPERATURE. M. V. Dekhtyar and N. M. Kazantseva (Lomonosov Moscow State Univ.). *Fiz. Metal. i Metalloved.* **8**, 412-16(1959) Sept. (In Russian)

Magnetic properties of Ni-Fe (50% Ni) alloys vary with structural changes following thermal treatment. An abnormal temperature effect on magnetic saturation, maximum absorption, and corrosive force was observed in 1200°C annealed alloy during heating from 300 to 360°C. The process is induced by order formation in disordered fast-cooled alloys. The anomalous properties are retained at room temperature. Specimens subjected to ordering annealing did not show anomalous magnetic properties at the investigated temperatures. (tr-auth)

## 12958

MECHANICAL PROPERTIES OF Al-Ni ALLOYS. V. A. Pavlov and I. A. Pereturnia (Inst. of Metal Physics, Academy of Sciences, USSR). *Fiz. Metal. i Metalloved.* **8**, 417-25(1959) Sept. (In Russian)

The yield point of Ni-Al alloy as a function of solid solution concentration, temperature, and the rate of deformation was studied. A strengthening of the solid solution takes place with Al admixture, with the exception of low-concentration regions from 0.025 to 0.05% Al. In this region the yield point was first reduced and then increased. With increased Al the yield point increases as function of the temperature and rate of deformation. The yield point of alloys with 1.5 and 2.93% Al varies with temperature. (R.V.J.)

## 12959

EFFECTS OF GEOMETRIC DISTORTIONS ON THE BACKGROUND INTENSITY DISTRIBUTION IN X-RAY OR NEUTRON CRYSTALLOGRAMS. M. A. Krivoglaз (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). *Fiz. Metal. i Metalloved.* **8**, 514-30(1959) Oct. (In Russian)

The background distribution near the lines or spots in Debye or Laue crystallograms was investigated. The scattering is induced by variability of atomic scattering factors and atomic radii. Formulas are derived for determining correlation parameters (considering the geometric deformations) according to experimentally distributed background intensities on Debye crystallograms. (R.V.J.)

## 12960

MAGNETIC AND ELECTRIC PROPERTIES AND HARDNESS OF HIGH-CARBON ALLOYED STEELS IN ANNEALED STATE. M. N. Mikhnev and G. S. Tomilov (Inst. of Metal Physics, Academy of Sciences, USSR). *Fiz. Metal. i Metalloved.* **8**, 543-56(1959) Oct. (In Russian)

The cohesive force and saturation magnetization in correlation with hardness and microstructure in a series of Cr, Mn, and W alloyed carbon steels were investigated in the temperature range 780 to 1250°C. The relation of magnetic properties, following annealing, to the structure of the steel Sh x 15 SG (1.06% C, 1.45% Cr, 1.07 Mg, and 0.50% W) was studied as a basis for the magnetic method for steel quality control. (tr-auth)

## 12961

DIFFUSION REACTION IN BINARY METAL-GAS SYSTEMS. V. A. Arkharov and E. B. Blankova (Gor'kiĭ Urals State Univ., USSR). *Fiz. Metal. i Metalloved.* **8**, 569-73(1959) Oct. (In Russian)

The results of diffusion studies on Co-Se, Cr-Se, Fe-Se, Mn-Se, Ni-Se, Ti-Se, and V-Se systems are tabulated. Reciprocal metal-gas diffusion was observed in Cr-Se, Fe-Se, Mn-Se, and Ni-Se systems at all stages of sintering up to 1000°C, while in Co-Se, Ti-Se, and V-Se the reciprocal diffusion was not observed up to 850, 800, and 750°C, respectively. Sintering in these systems was the result of metalloid diffusion into the metal-sinter interface. A reciprocal Co, Ti, and V metal diffusion takes place at higher temperature than those quoted. The same observations hold true for all metal-tellurium systems where practically all sintering is the result of tellurium diffusion with metals diffusing at much higher temperatures. (R.V.J.)

## 12962

DIFFUSION REACTION IN BINARY METAL-GAS SYSTEMS. [PART] III. V. I. Arkharov, E. B. Blankov, N. A. Sukhova, and R. A. Entelis (Gor'kiĭ Urals State Univ., USSR). *Fiz. Metal. i Metalloved.* **8**, 636-8(1959) Oct. (In Russian)

A supplementary study was made of the diffusion mechanism in Co-P, Fe-P, Nb-S, Nb-Se, Nb-Te, Zr-S, Zr-Se, and Zr-Te systems in order to verify the previously postulated theory on the correlation between the increased role of homopolar bonds in the diffusion products and the increased relative role played by the metalloid. The correlation of the data obtained by various methods indicates one-sided phosphorus diffusion at 400 to 600°C. In the Zr and Nb systems the diffusion of metalloids (S, Se, and Te) is observed at 400 to 1000°C. Hence, the selection of systems on the basis of a gradual increase of the relative role of homopolar bonds in transition elements leads to an increase in the metalloid participation in diffusion processes. (R.V.J.)

#### 12963

ELASTIC CONSTANTS OF YTTRIUM SINGLE CRYSTALS IN THE TEMPERATURE RANGE 4.2–400°K. J. F. Smith and J. A. Gjevne (Iowa State Univ. of Science and Tech., Ames). *J. Appl. Phys.* **31**, 645–7(1960) Apr.

The five independent elastic constants for yttrium single crystals have been determined by the pulse-echo technique over the temperature range, 4.2–400°K. The experimental values extrapolated to 0°K are:  $C_{11} = 8.34 \pm 0.02$ ,  $C_{33} = 8.01 \pm 0.02$ ,  $C_{44} = 2.690 \pm 0.006$ ,  $C_{12} = 2.91 \pm 0.03$ , and  $C_{13} = 1.9 \pm 0.4$  in units of  $10^{11}$  d/cm<sup>2</sup>. The degree of elastic anisotropy is low throughout the entire temperature range. The curves illustrating the temperature dependence of the elastic constants show several inflections, and the curve for  $C_{11}$  crosses that for  $C_{33}$  near 390°K. The behavior is somewhat unusual, and is probably explicable on the basis that the degree of band overlap in yttrium is quite sensitive to interatomic spacing. Such a sensitivity has previously been postulated to explain the temperature dependence of the Hall coefficient. (auth)

#### 12964

MICRO-STRUCTURES OF SINTERED URANIUM DIOXIDE PELLETS. S. Takahashi, T. Kubota, H. Doi, and H. Uchikoshi (Mitsubishi Atomic Power Ind., Inc., Japan and Mitsubishi Metal Mining Co., Ltd., Japan). *J. Atomic Energy Soc. Japan* **2**, 73–7(1960) Feb. (In Japanese)

Microstructure of outer and fractured surfaces of sintered uranium dioxide pellets was investigated using an electron microscope. The technique of carbon atomic replica was adopted for the preparation of samples. The structure of outer and fractured surfaces changes markedly during the progress of sintering. The degree of sintering, sintering conditions, and minute additives are reflected in the shape and microstructure of pores on fractured surfaces. Pores in pellets well sintered in hydrogen are bounded by well developed facets, some of them showing perfect cubic holohedral symmetry. Their facets are indexed as {111}, {100}, {110}, and higher indices nearly parallel to {110}. Facets indexed as {110} consist of repeated steps having much smaller facets {111}. Pores in pellets sintered *in vacuo* and in earlier stage pellets sintered in hydrogen show rounded and sometimes spherical shapes. Small facets bounded by concentric steps are often observed on the wall of rounded and spherical pores. Their facets are indexed as {111}, {100}, and {110}. The {110} appears less frequently than others. Much smaller facets nearly parallel to {111} or {110} but slightly deflected to {100} are sometimes observed. Small amounts of alumina or titania as additives affect the shape of pores and the mode of precipitation on pore walls. Alumina tends to develop facets on pores, while titania keeps pores spherical. (auth)

#### 12965

PROPERTIES OF COLD DRAWN URANIUM RODS. I. ON THE THERMAL EXPANSION COEFFICIENT AND THE THERMAL CYCLING GROWTH OF RECRYSTALLIZED SPECIMENS. K. Soeno (Hitachi Ltd., Japan). *J. Atomic Energy Soc. Japan* **2**, 89–95(1960) Feb. (In Japanese)

$\beta$ -treated, cold-drawn uranium rods were studied to determine the relation between the thermal expansion coefficient in the drawing direction and the working degree (2 to 30% reduction in area); the change of the coefficient due to grain growth after recrystallization; and the thermal cycling growth of recrystallized specimens. The preferred orientation was obtained by only two percent work, and the dimensional instability was apparent on thermal cycling. The {010} plane as one component of preferred orientation was arranged parallel to the rod axis regardless of the degree of working. The grain growth after recrystallization was found to affect the formation of the preferred orientation. (D.L.C.)

#### 12966

THERMODYNAMIC PROPERTIES OF NONSTOICHIOMETRIC URANIA-THORIA SOLID SOLUTIONS. S. Aronson and J. C. Clayton (Westinghouse Electric Corp., Pittsburgh). *J. Chem. Phys.* **32**, 749–54(1960) Mar.

A solid state electrochemical technique was used to obtain thermodynamic information on urania-thoria solid solutions of compositions  $U_{1-y}Th_yO_{2+x}$  with values of  $y$  of 0.9 to 0.3 and values of  $x$  of 0.02 to 0.16. The electrochemical cells were of the type  $Fe, FeO | (ZrO_2 + CaO) | U_{1-y}Th_yO_{2+x}, Pt$ . Measurements were made at 1150 to 1350°K. Partial molar free energies, entropies, and enthalpies of solution of oxygen in the solid solutions were calculated. The partial molar free energy decreased negatively with increasing thorium content for thorium concentrations greater than 30 atomic percent. The partial molar entropy increased negatively with increasing oxygen content or with increasing thorium content. The experimental results are discussed in connection with a mechanism of interstitial solution of oxygen ions in the fluorite lattice. A thermodynamic equation for the entropy was developed which gives semiquantitative agreement with the experimental data. (auth)

#### 12967

THERMODYNAMIC PROPERTIES OF TRIFLUOROMETHANETHIOL FROM 12°K TO ITS BOILING POINT. ENTROPY FROM MOLECULAR AND SPECTROSCOPIC DATA. R. E. Dininny and E. L. Pace (Western Reserve Univ., Cleveland). *J. Chem. Phys.* **32**, 805–9(1960) Mar.

The heat capacity of trifluoromethanethiol was measured at 12 to 227°K. The heat of fusion at the triple point temperature, 116.04°K, was 1177 cal mole<sup>-1</sup>. The heat of vaporization at the normal boiling point, 235.16°K, was 4798 cal mole<sup>-1</sup>. The vapor pressure was measured, and the data represented by the equation  $\log_{10} p_{\text{mm}} = (-1352.568/T) - 2.686918 \log_{10} T + 15.00409$ . The entropy of trifluoromethanethiol gas calculated from the calorimetric data was  $69.45 \pm 0.17$  eu at 235.16°K. The result calculated from spectroscopic data and structural parameters for the molecule was 70.19 eu. The discrepancy of  $0.74 \pm 0.17$  eu was attributed to a potential barrier of  $1540 \pm 260$  cal mole<sup>-1</sup> which restricted the internal rotation of the trifluoromethyl group. (auth)

#### 12968

INFRARED AND RAMAN SPECTRA OF FLUORINATED ETHANES. XII. 1,1,2,2-TETRAFLUOROETHANE. Peter



July 15, 1960

Klaboe and J. Rud Nielsen (Univ. of Oklahoma, Norman). *J. Chem. Phys.* **32**, 899-907 (1960) Mar.

The infrared absorption spectra of gaseous  $\text{CHF}_3$ - $\text{CHF}_2$  at five temperatures between 30 and 170°C and of the crystalline solid at -170°C were obtained with a Perkin-Elmer double-pass spectrometer equipped with  $\text{CaBr}_2$ ,  $\text{NaCl}$ , and  $\text{LiF}$  prisms. The Raman spectrum of the liquid at 20, -25, and -80°C was photographed with a 3-prism glass spectrograph of reciprocal linear dispersion 15 Å/mm at 4358 Å, and polarization measurements were made. In the gaseous and liquid states the compound exists as a mixture of two rotational isomers of symmetries  $C_{2h}$  and  $C_2$ , respectively, the former (trans) being the more stable. In the crystalline state only the trans configuration was present. A value of  $1160 \pm 100$  cal/mole was found for the enthalpy difference  $\Delta H^0$  in the gas. In the liquid,  $\Delta H^0$  was much smaller. With some uncertainties, the vibrational fundamentals were assigned for each isomer. (See also *NSA* Vol. II abstract No. 9243.) (auth)

#### 12767

PARAMAGNETIC SUSCEPTIBILITY OF POLYCRYSTALLINE THULIUM FROM 300 TO 1500°K. Sigurds Aarås (U. S. Steel Corp. Research Center, Monroeville, Penna.). *J. Chem. Phys.* **32**, 951-2 (1960) Mar.

The magnetic susceptibility of polycrystalline thulium was measured from 300 to 1500°K. The Weiss-Curie law was satisfied between those temperatures. The parametric Curie temperature ( $17.4 \pm 0.5^\circ\text{K}$ ) and the Curie constant ( $(4.37 \pm 0.13) \times 10^{-2} \text{ cm}^3 \text{ Kg}^{-1}$ ) were determined. The effective Bohr magneton number corresponding to the measured Curie constant was determined to be  $7.68 \pm 0.10$ . (C.J.G.)

#### 12770

SOME PROPERTIES OF ALUMINUM NITRIDE. K. M. Taylor and Camille Lenie (Carborundum Co., Niagara Falls, N. Y.). *J. Electrochem. Soc.* **107**, 308-14 (1960) Apr.

Aluminum nitride crystals in the form of six-sided prismatic needles, up to 0.5 mm in diameter by 30 mm long, and thin plates, 2 to 3 mm in diameter, were prepared by vaporization of aluminum in a nitrogen atmosphere at temperatures ranging from 1800 to 2000°C, and the properties of the crystals determined. An aluminum nitride body, having a density of 98% of the theoretical value was prepared by hot pressing of the fine powder, and a study made of its properties. (auth)

#### 12771

RESISTANCE TO DEFORMATION OF ALUMINIUM AND SOME ALUMINIUM ALLOYS. ITS DEPENDENCE ON TEMPERATURE AND RATE OF DEFORMATION. R. R. Arnold and R. J. Parker (Imperial Chemical Industries, Ltd., Birmingham, Eng.). *J. Inst. Metals* **88**, 255-9 (1960) Feb.

Resistance to compressive deformation of commercially pure aluminum, three non-heat-treatable aluminum alloys (Al-Mn, Al-2.25% Mg, and Al-5% Mg) and two heat-treatable aluminum alloys (Al-Si-Mg and Al-Cu-Si-Mg) has been determined by experiments on a cam plastometer. Data are presented for strain rates within the range 1 to 30 in./in./sec, and temperatures varying from 300 to 550°C. The resistance to deformation of aluminum alloys in the hot-working range varies greatly; i.e., the value for the high-strength aluminum-5% magnesium alloy at 300°C is about eight times that of commercially pure aluminum at 500°C. The higher-strength alloys were susceptible to thermal-softening effects, and resistance to deformation

of these materials decreased after moderate reductions. (auth)

#### 12772

"GIANT" CHROMIUM INTERMETALLICS IN COMMERCIAL Al-Zn-Mg-Cu ALLOYS. L. E. Steele (Northern Aluminium Co., Ltd., Rogerstone, Eng.) and D. L. W. Collins (Aluminium Labs., Ltd., Banbury, Eng.). *J. Inst. Metals* **88**, 260-5 (1960) Feb.

Very coarse crystals, up to 0.1 in. in length, found in large extrusions of an alloy to specification D.T.D. 683a, were identified as primary crystals of  $\text{CrAl}_7$ , with chromium partially replaced by other transition elements, which grew under virtually isothermal conditions in the liquid-metal head during semi-continuous casting. Variations in casting conditions, short of turbulent pouring which was undesirable for other reasons, did not prevent their occurrence. It was established that the boundary between the "primary Al" and "primary  $\text{CrAl}_7$ " regions in a D.T.D. 683a alloy containing Cr, Mn, Fe, and Ti is represented closely by the equation:  $\% \text{Cr} = 0.244 - 0.090 \text{ Mn}\% - 0.142 \text{ Fe}\% - 0.797 \text{ Ti}\%$ , and from examination of published information it is concluded that this equation is applicable to a wide range of Al-Zn-Mg-Cu alloys. The application of composition limits in accordance with these results prevented further occurrence of the primary crystals in commercial practice. (auth)

#### 12773

STRENGTH, STABILITY, AND THE EQUICOHESIVE POINT. E. E. Underwood (Battelle Memorial Inst., Columbus, Ohio). *J. Inst. Metals* **88**, 266-71 (1960) Feb.

A series of high-purity alloys based on iron-18% chromium, balance nickel, was prepared to include the  $\alpha$ , ( $\alpha + \gamma$ ), and  $\gamma$  phase fields. Strengths were measured by means of creep, tensile, and hardness tests. Stability was evaluated from the rate of decrease of high-temperature strength with time. It is shown that the ambiguity connected with the equicohesive temperature can be eliminated when time or strain-rate effects are accounted for, thus conferring a unique value on the transition between low- and high-temperature behavior. This fixed value is called the equicohesive point, rather than the equicohesive temperature. (auth)

#### 12774

THE TENSILE STRENGTH OF SOME REFRACTORY METALS AT HIGH TEMPERATURES. B. L. Mordike (Univ. of Cambridge, Eng.). *J. Inst. Metals* **88**, 272-5 (1960) Feb.

The tensile strengths of the refractory metals niobium, tantalum, tungsten, and molybdenum were measured in the range 0 to 2300°C. Up to 800°C a standard Hounsfield tensometer was used, but from 800 to 2200°C the measurements were made in a carbon-tube vacuum furnace. The behavior of these metals was comparable in every respect, at equivalent homologous temperatures, with that of the lower-melting-point metals. The upper temperature limit was imposed by a reaction between carbon vapor from the furnace tube and the specimen. Above 2000°C a carbide was formed on the surface and diffused into the specimen, thereby affecting the mechanical properties appreciably. (auth)

#### 12775

COMMERCIAL PURE TITANIUM-ARSENIC ALLOYS. CONSTITUTION AND ROOM-TEMPERATURE TENSILE PROPERTIES. R. Haynes (Imperial Chemical Industries, Ltd., Birmingham, Eng.). *J. Inst. Metals* **88**, 277-9 (1960) Feb.

Titanium-arsenic alloys undergo a peritectoid reaction at  $\sim 900^\circ\text{C}$ , in which  $\beta$  solid solution reacts with a compound, shown to be  $\text{Ti}_4\text{As}$ , to form  $\alpha$  phase containing  $\sim 0.05$  wt.% (0.03 at.%) arsenic. Solubility of arsenic in  $\beta$  phase increases slowly with temperature, reaching a maximum of  $\sim 1.6$  wt.% (1 at.%) at the eutectic temperature,  $1355 \pm 15^\circ\text{C}$ . The eutectic composition is  $\sim 17.5$  wt.% (12 at.%) arsenic. Up to 1 wt.% arsenic exerts only a slight strengthening effect on commercially pure titanium, accompanied by a small loss in ductility. Solution-treatment at temperatures in the  $\beta$  field increases the strength above the level obtained by annealing in the  $(\alpha + \text{Ti}_4\text{As})$  field and this strengthening can be further enhanced by ageing at  $550^\circ\text{C}$ . Optimum properties obtainable are similar to those of low-strength titanium alloys. (auth)

## 12976

### CONSTITUTION OF NICKEL-BASE TERNARY ALLOYS.

#### I. NICKEL-MOLYBDENUM-ALUMINIUM SYSTEM.

R. W. Guard and E. A. Smith (General Electric Research Lab., Schenectady, N. Y.). J. Inst. Metals **88**, 283-5 (1960) Feb.

The nickel-rich portions of the Ni-Mo-Al alloy and the Ni-Mo-Si system were investigated. A ternary alloy designated by  $\Psi$  was found at  $1175^\circ\text{C}$  in the vicinity of Ni 58, Mo 7.5, Al 34.5 at.%, confirmed by the presence of a new set of x-ray-diffraction lines. None of the binary compounds  $\text{Ni}_3\text{Al}$ ,  $\text{NiAl}$ , or  $\text{NiMo}$  shows appreciable solubility in the ternary section. X-ray-diffraction studies confirmed the presence of a ternary system designated by  $\Psi$  at  $1100^\circ\text{C}$  and composition Ni 50, Mo 32, Si 18 at.%. The structures of these ternary compounds were not determined. (B.O.G.)

## 12977

DECOMPOSITION OF URANIUM DIOXIDE AT ITS MELTING POINT. J. S. Anderson, J. O. Sawyer, H. W. Worner, G. M. Willis, and M. J. Bannister (Univ. of Melbourne). Nature **185**, 915-16 (1960) Mar. 26.

The fusion of uranium dioxide in an argon gas arc furnace at  $2800 \pm 100^\circ\text{C}$  consistently gave lustrous grey metallic-looking products, with a gross analytical composition  $\text{UO}_{2-x}$  ( $0.15 > x > 0$ ). The oxygen deficiency was found to depend on the time duration in the molten state; after prolonged fusion a limiting composition of  $\text{UO}_{1.88}$  was approached. The fused material was quite stable in air, but when powdered it combined with oxygen to a content of  $\text{UO}_{2.005}$ . X-ray-diffraction studies of the fused product revealed two phases, major and minor. The x-ray data for the minor phase are compared with  $\alpha$ - and  $\beta$ -uranium. (B.O.G.)

## 12978

AN INVESTIGATION OF PROPERTIES OF THIN LITHIUM FILMS BY USE OF THE  $\text{Li}^7(p,n)\text{Be}^7$  REACTION. J. E. Monahan and F. P. Mooring (Argonne National Lab., Lemont, Ill.). Nuclear Instr. and Methods **6**, 343-53 (1960) Mar. (In English)

The  $(p,n)$  reaction in thin films of lithium and lithium fluoride evaporated on tantalum backings is used to obtain a quantitative measure of possible irregularities in the thickness of such films. Evidence is presented that metallic lithium films are not only nonuniform in thickness but that this apparent nonuniformity becomes more pronounced as these films are bombarded with protons. On the other hand, lithium fluoride films seem to be of uniform thickness but the effect of proton straggling produces an apparent nonuniformity which can be analyzed to give the energy spectrum of protons emerging from the films. Consequently this type of measurement can be used to obtain the stopping power and straggling distribution of protons in

targets which give rise to a  $(p,n)$  or  $(p,\gamma)$  reaction. A simple method of analyzing conventional "rise-curve" measurements is suggested. It gives a more nearly accurate calibration of neutron energies and a more complete description of the neutron energy spectrum. (auth)

## 12979

BERYLLIUM OXIDE AND ITS USES. J. Elston (Commissariat à l'Énergie Atomique, Saclay, France). Nuclear Power **5**, No. 48, 131-3 (1960) Apr.

Sintered specimens of  $\text{BeO}$  were irradiated to determine the changes in the physical and mechanical properties caused by radiation below  $100^\circ\text{C}$ . These changes can be explained partially by displacement of ions, creation of faults in the crystal lattice (Wigner effect), and the formation of  $\text{Be}^0$  gas under the action of fast neutrons from the  $(n,2n)$  and  $(n,\alpha)$  reactions. The use of beryllium oxide at high temperatures, apart from irradiation effects, is limited by the risks of volatilization in the presence of steam above  $1100^\circ\text{C}$ . In addition the mechanical characteristics sensibly worsen with temperature. It is probable that an optimum density exists for particular uses of  $\text{BeO}$  made by sintering. In that case, it is possible that bars obtained by natural sintering give better results than those produced by sintering under pressure because of their greater homogeneity. (B.O.G.)

## 12980

ON THE STABILITY OF THE DISLOCATION SUBSTRUCTURE IN QUENCHED ALUMINIUM. R. Vandervoort and J. Washburn (Univ. of California, Berkeley). Phil. Mag. (8) **5**, 24-9 (1960) Jan.

Dislocation loops formed by quenching thin aluminum specimens in iced brine were studied by the transmission electron microscope technique. As-quenched specimens contained loops 200 Å to 600 Å in diameter with a density of  $10^{15}$  loops per cubic centimeter. Quenched-in loops were completely removed by heating to  $200^\circ\text{C}$  for ten minutes or by cold rolling to a 5% reduction in thickness. The disappearance of the loops was accompanied by an increase in the number of irregular kinked dislocation lines. (auth)

## 12981

AN APPROXIMATE CORRELATION BETWEEN THE ELECTRON FERMİ ENERGY AND WORK FUNCTION OF A METAL. J. H. O. Varley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8) **5**, 64-9 (1960) Jan.

The Fermi energy of the free electrons in a metal is estimated and correlated to the electronic work function:  $\chi/\epsilon = 0.5$ . Such a straightforward correlation is found to hold approximately for most metals in Groups I to IV of the periodic table. (auth)

## 12982

ELECTRICAL RESISTIVITY OF EUROPIUM AND YTTERBIUM. M. A. Curry, S. Legvold, and F. H. Spedding (Iowa State Univ. of Science and Tech., Ames). Phys. Rev. **117**, 953-4 (1960) Feb. 15.

Electrical resistivity measurements on europium and ytterbium metals from  $1.3^\circ$  to  $300^\circ\text{K}$  are reported. Europium exhibits a sharp peak in its resistivity at  $90^\circ\text{K}$  which must correspond to its magnetic ordering temperature. The shape of the peak indicates antiferromagnetic ordering below  $90^\circ\text{K}$ . Ytterbium has no sharp anomalies in its resistivity. (auth)

## 12983

ELECTRICAL RESISTIVITY OF DYSPROSIUM SINGLE CRYSTALS. P. M. Hall, S. Legvold, and F. H. Spedding (Iowa State Univ. of Science and Tech., Ames). Phys. Rev. **117**, 971-3 (1960) Feb. 15.



Resistivity measurements are reported on two single crystals of hcp dysprosium metal in the temperature range 1.3 to 400°K. The two magnetic transitions at 90 and 175°K are very evident in the resistivity. Significant anisotropy is observed only above 175°K, which is the paramagnetic range; at 400°K,  $\rho_{\perp}/\rho_{\parallel} = 1.5$ . A prediction for the resistivity of polycrystalline dysprosium based on these measurements is seen to be in good agreement with the resistivity of a polycrystalline sample. (auth)

## 12904

FERROMAGNETIC RELAXATION MECHANISM FOR  $M_z$  IN YTTRIUM IRON GARNET. M. Sparks and C. Kittel (Univ. of California, Berkeley). *Phys. Rev. Letters* **4**, 232-4 (1960) Mar. 1.

A summary of the likely relaxation process of the magnetic moment component parallel to the static magnetic field in yttrium iron garnet at 2 to 30°K is given. The relaxation rate of the S modes for Raman processes in which, by magnetic dipolar coupling between an S mode and a thermal spin wave, the Z component of the magnetic moment changes by  $\pm 2\mu_B$ . Through calculations, it is shown that  $M_z$  is expected to relax by magnetic dipole interaction with thermal spin waves at a rate comparable with observation. (C.J.G.)

## 12955

MECHANISMS OF VOLUME SELF-DIFFUSION IN  $\alpha$ -Fe AND  $\gamma$ -Fe. C. J. Meechan (Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.). *Phys. Rev. Letters* **4**, 284-6 (1960) Mar. 15.

Mechanisms of volume self-diffusion in  $\alpha$ -Fe and  $\gamma$ -Fe were examined by the method of Kuczynski. This method is based on an expression which relates the dimensions of a sintered interface between two particles to D, the coefficient of volume self-diffusion. The values of D for  $\alpha$ - and  $\gamma$ -Fe were determined to be  $< 6 \times 10^{-14}$  cm<sup>2</sup>/sec at 885°C and  $3.5 \times 10^{-13}$  cm<sup>2</sup>/sec at 935°C, respectively. Good agreement was obtained for the D value of  $\gamma$ -Fe compared with the value of D for  $\alpha$ -Fe when compared to tracer data. It is concluded that the sintered fillets in the  $\gamma$ -Fe (fcc structure) were established via a defect mechanism, presumed to be vacancies. A diffusion mechanism which does not involve lattice defects is postulated to be primarily responsible for volume diffusion in  $\alpha$ -Fe (bcc structure). (C.J.G.)

## 12986

ENHANCEMENT OF BREMSSTRAHLUNG PRODUCED BY 575-MEV ELECTRONS IN A SINGLE CRYSTAL OF SILICON. A. N. Saxena (Stanford Univ., Calif.). *Phys. Rev. Letters* **4**, 311-12 (1960) Mar. 15.

Experiments were performed to observe the enhancement of the bremsstrahlung produced by 575-Mev electrons when they pass through a single crystal of silicon. The bremsstrahlung was monitored by a double-ionization chamber consisting of two identical ionization chambers constructed in one envelope, each preceded by beryllium converters. (C.J.G.)

## 12987

THEORY OF THE MAGNETIC AND SPECTROSCOPIC PROPERTIES OF NEPTUNIUM HEXAFLUORIDE. J. C. Eisenstein (National Bureau of Standards, Washington, D. C.) and M. H. L. Pryce (Bristol Univ., Eng.). *Proc. Roy. Soc. (London)* **A255**, 181-98 (1960) Apr. 5.

The magnetic properties and the optical absorption spectrum of  $NpF_6$  are interpreted on the basis of an appropriate model for the molecule. The theory, in its simplest form, is not in perfect accord with all the available data.

Consequently, various physical effects such as covalence, vibronic interactions, the Coriolis force on the unpaired electron, and the Jahn-Teller effect, which might affect the agreement of theory and experiment are discussed in a qualitative or semi-quantitative way. It is pointed out that the g value may vary with temperature so that one must be cautious when comparing the paramagnetic resonance and susceptibility data with theoretical predictions. The Coriolis interaction between the electron (effective) spin and the molecular rotation was found to be sufficiently large to modify the magnetic resonance frequency by an appreciable amount when rotation is free. This is proposed as a reason why paramagnetic resonance has not been observed in gaseous  $NpF_6$ . Experiments which would help to clarify the interpretation are suggested. (auth)

## 12989

THE ANISOTROPIC THERMOELECTRIC POWER OF GRAPHITE. L. C. F. Blackman, P. H. Dundas, and A. R. Ubbelohde (Imperial Coll. of Science and Tech., London). *Proc. Roy. Soc. (London)*, **A 255**, 293-306 (1960) Apr. 19.

In order to characterize the anisotropy, measurements of thermoelectric power at ordinary temperatures were made as a function of direction on various specimens of graphite. These included commercial polycrystalline graphite partly oriented during its manufacture, compacts of small near-ideal crystal flakes oriented by compression, well-oriented pyrolytic graphite, and natural graphite with good columnar orientation parallel to the  $\alpha$ -axis. Measurements were also made on the thermoelectric force between well oriented pyrolytic and polycrystalline graphite, over the temperature range 90° to 2800°K. Effects of deliberately introduced crystal defects on the thermoelectric power were examined for crystal compounds in which the graphite acts as electron donor or electron acceptor. Results are discussed in relation to some current theories of thermoelectric power in solids. (auth)

## 12989

THE THERMAL EXPANSION ANOMALY OF GADOLINIUM. R. R. Birss (Imperial Coll. of Science and Tech., London). *Proc. Roy. Soc. (London)*, **A 255**, 398-406 (1960) Apr. 19.

The thermal expansion of polycrystalline gadolinium was measured from 80 to 750°K. The anomaly in the expansivity in the region of the ferromagnetic Curie point corresponds to an isotropic volume strain of  $2.7 \times 10^{-3}$ . The connection of the thermal expansion anomaly with the magnetostriction constants and the (hexagonal) magneto-elastic coupling constants is discussed. (auth)

## 12990

CREEP OF INDIUM, LEAD, AND SOME OF THEIR ALLOYS WITH VARIOUS METALS. Johannes Weertman (Northwestern Univ., Evanston, Ill.). *Trans. Met. Soc. AIME* **218**, 207-18 (1960) Apr.

High-temperature creep experiments were carried out on indium, lead, and on binary substitutional alloys of In-Pb, In-Sn, In-Tl, In-Cd, In-Hg, Pb-Bi, Pb-Sn, Pb-In, and Pb-Cd. The stress at which the power law creep equation breaks down was found to be much smaller for indium and lead than for metals with larger elastic moduli. The exponent over the stress in the power law creep equation was found to decrease upon alloying from values close to 4.5 to values near 3. (auth)

## 12991

DETERMINING BORON DISTRIBUTION IN METALS BY NEUTRON ACTIVATION. Barbara A. Thompson (General Electric Co., Schenectady, N. Y.). *Trans. Met. Soc. AIME* **218**, 228-31 (1960) Apr.

A high-resolution method for the location of boron-rich areas in metallurgical and biological specimens is adapted for general use on a routine basis. The method utilizes neutron activation and autoradiography. Alpha-particles emitted by boron nuclei upon neutron capture are recorded on a photographic emulsion. The resulting  $\alpha$ -particle tracks show the location of boron-rich areas. Experimental techniques, interferences, and limitations of the method are discussed. The method is most useful where there is marked segregation of boron. In this type of sample, the segregation can be observed when the nominal boron concentration is as low as 0.0006 pct. (auth)

#### 12992

BETA DECOMPOSITION IN Zr-U-O ALLOYS. D. L. Douglass (Battelle Memorial Inst., Columbus, Ohio). *Trans. Met. Soc. AIME* **218**, 237-42(1960) Apr.

The  $\beta$  decomposition of Zr-U-O alloys was studied during an interrupted quench from the  $\alpha + \beta$  region. Decomposition was more rapid than in binary Zr-U alloys of the same uranium content or of equivalent  $\beta$  composition. The rapid transformation is ascribed to the presence of the primary  $\alpha$  phase which provided nucleation sites and which permitted preferential partitioning of oxygen to the  $\alpha$  phase and of uranium to the  $\beta$  phase. (auth)

#### 12993

EFFECT OF CARBIDE DISPERSION IN MOLYBDENUM ALLOYS. Winston H. Chang (General Electric Co., Cincinnati). *Trans. Met. Soc. AIME* **218**, 254-6(1960) Apr.

The phase identification results on several Mo-base alloys are presented. These results are correlated with strength data and microstructural studies and indicate that carbide dispersion may contribute significantly to raising the recrystallization temperature and strength of Mo alloys. It is shown that the degree of carbide dispersion, and hence the extent of strengthening, is governed by the metal/carbon ratio which, in turn, depends on both the carbon content and the presence of stable-carbide-forming alloying elements. (auth)

#### 12994

THE SELF-DIFFUSION OF COLUMBIUM. R. Resnick and L. S. Castleman (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). *Trans. Met. Soc. AIME* **218**, 307-10(1960) Apr.

The self-diffusion coefficient of columbium was measured over the temperature range 1585 to 2120°C, using the radioactive isotope Nb<sup>95</sup> as the tracer. The data for the temperature dependence of the self-diffusion coefficient are best fitted by the equation  $D = (12.4 \pm 0.8) \exp [(-105,000 \pm 3000)/RT] \text{ cm}^2/\text{sec}$ . (auth)

#### 12995

STABILIZATION OF CERTAIN Ti<sub>2</sub>Ni-TYPE PHASES BY OXYGEN. M. V. Nevitt (Argonne National Lab., Lemont, Ill.). *Trans. Met. Soc. AIME* **218**, 327-31(1960) Apr.

In the systems Ti-Mn-O, Ti-Fe-O, Ti-Co-O, and Ti-Ni-O the boundaries of the Ti<sub>2</sub>Ni-type phases were determined at one or more temperatures and the variation of the lattice parameter with oxygen content was determined. Densities were calculated from the lattice parameters and compared with measured density values. The results indicate that the occurrence of the phase in these systems can be correlated qualitatively with valency electron concentration, and that the role of oxygen is that of an electron acceptor. The lower limit of oxygen solubility appears to be determined by the valencies of Mn, Fe, Co, and Ni, while the maximum oxygen concentration

coincides with the filling of the 16 (c) positions of the O<sub>k</sub>-Fd 3m space group. (auth)

#### 12996

CRITICAL RECRYSTALLIZATION OF ZIRCONIUM. Jack C. Bokros (General Atomic Div., General Dynamics Corp., San Diego, Calif.). *Trans. Met. Soc. AIME* **218**, 351-3(1960) Apr.

At temperatures above 950°F, zirconium which was strained a critical amount will experience critical recrystallization. The large grain size thus formed can result in a reduction in the fatigue life by a factor of 2 to 9 at both high and low temperatures. The critical strains for zirconium vary from 15% at 900°F to about 2% at 1125°F, while those for Zircaloy III vary from 15% at 1050°F to 5% at 1200°F. Zircaloy II experiences no critical recrystallization up to 1200°F. (auth)

#### 12997

IMPROVEMENT OF ENDURANCE PROPERTIES OF HEAT-RESISTANT NICKEL ALLOYS BY SMALL ADDITIONS OF BORON AND ZIRCONIUM. Karl Erich Volk and A. W. Franklin (Defence Research Lab., Melbourne and Mond Nickel Co., London). *Z. Metallk.* **51**, 172-9(1960) Mar. (In German)

The improvement of the endurance properties by the addition of boron and zirconium to three different alloy types on the base nickel-chromium and nickel-chromium-cobalt respectively, which have precipitation-hardening additives of aluminum and titanium, is investigated. The results show that these additives do not only have a purification effect but they have a direct influence on the resistance to deformation, too. (auth)

#### 12998

RECRYSTALLIZATION BEHAVIOR OF COLUMBIUM. R. T. Begley and L. L. France (Westinghouse Research Labs., Pittsburgh). p.183-98 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The recrystallization behavior of high-purity niobium prepared by electron bombardment melting, was determined as a function of annealing time, annealing temperature, and prior deformation. Annealing time ranging from 0.1 to 100 hr, annealing temperatures from 700 to 1200°C, and prior deformations of 60, 80, and 95% were investigated. The course of recrystallization was followed by means of metallographic examination, hardness determinations, and x-ray analysis. Observations on grain growth at higher temperatures were made. Niobium was found to follow classical recrystallization and grain growth behavior. (auth)

#### 12999

RECRYSTALLIZATION BEHAVIOR OF A DISPERSION-HARDENED MOLYBDENUM-BASE ALLOY. T. A. Prater (General Electric Co., Schenectady, N. Y.). p.199-209 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The recrystallization behavior of dispersion-hardened molybdenum-base alloys with recrystallization temperatures of nearly 3000°F has been studied. The dependence of recrystallization temperature on amount of deformation has been established. It has been found that the recrystallization temperature is greatly influenced by the presence of a tensile stress during recrystallization. The resulting



structure has been found to be different when recrystallization takes place in stressed and relatively stress-free materials. (auth)

### 13000

RECRYSTALLIZATION OF MOLYBDENUM- $\frac{1}{2}$  pct TITANIUM ALLOY BY CHROMIUM AND NICKEL COATINGS. Gordon D. Oxx, Jr. (General Electric Co., Schenectady, N. Y.). p.211-25 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The effects of chromium and nickel coatings on the properties of molybdenum were investigated. It was found that molybdenum recrystallizes under these coatings. Microstructures of Mo-0.5 Ti, Cr and Ni plated, are given for various annealing temperatures and times. (B.O.G.)

### 13001

INVESTIGATION OF THE BRITTLE-DUCTILE TRANSITION IN VANADIUM. B. A. Loomis and O. N. Carlson (Ames Lab., Ames, Iowa). p.227-43 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

A brittle-ductile transition has been observed in vanadium metal subjected to tensile and bend tests. Bomb-reduced vanadium showed a change from ductile to brittle fracture at  $-65 \pm 10^\circ\text{C}$  and crystal bar vanadium showed a similar transition at  $-110 \pm 10^\circ\text{C}$ . The addition of small amounts of hydrogen, oxygen, nitrogen, or carbon raised the transition temperature. Small amounts of chromium, molybdenum, tantalum, and zirconium had anomalous maxima and minima effects on the transition temperature of vanadium. Thorium in small amounts had little effect. The lattice constant, electrical resistivity, and internal friction were studied as functions of temperature through the transition range. (auth)

### 13002

HIGH TEMPERATURE INTERNAL FRICTION OF TUNGSTEN. R. H. Schnitzel (Westinghouse Electric Corp., Bloomfield, N. J.). p.245-63 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The high temperature internal friction for various grades of tungsten was investigated for various annealing treatments over a temperature range 850 to  $2300^\circ\text{C}$ . The ratio of relaxed rigidity modulus to the unrelaxed rigidity modulus was also investigated for the various grades of recrystallized tungsten. A plateau exists in the internal friction versus temperature plot for polycrystalline tungsten, the magnitude and temperature range varying with annealing temperature. The internal friction of a large grained or "single crystal" tungsten has been investigated. Grain boundary peaks are obtained by subtracting the "single crystal" internal friction from the various plateaus in the internal friction versus temperature plot. From the extrapolated Wert and Marx plot, the activation energy for these grain boundary peaks is 150,000 to 140,000 cal per mole. (auth)

### 13003

VANADIUM-TANTALUM AND VANADIUM-CHROMIUM ALLOY SYSTEMS. O. N. Carlson, D. T. Eash, and A. L. Eustice (Ames Lab., Ames, Iowa). p.277-95 of "Reactive

Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

On the basis of data obtained from melting-point determinations, microscopic examination, and x-ray investigations, phase diagrams are proposed for the V-Ta and V-Cr alloy systems. The V-Ta system exhibits a continuous series of solid solutions at high temperatures with a minimum occurring in the solidus at  $1820^\circ\text{C}$  at a composition of about 30 wt.% Ta. An intermediate phase, tentatively assigned the formula  $\text{TaV}_2$ , precipitates from the solid solution at temperatures below  $1320^\circ\text{C}$ . A two-phase region extends from 27.5 to 87.5 wt.% Ta at  $900^\circ\text{C}$ . The V-Cr system forms a complete series of solid solutions with a minimum occurring in the solidus at  $1750^\circ\text{C}$  and approximately 70 wt.% Cr. No intermediate phase was found in this system. (auth)

### 13004

THE MICROGRAVIMETRIC SORPTION METHOD FOR THE STUDY OF HYDROGEN IN REACTIVE METALS. K. F. Andrew and E. A. Gulbransen (Westinghouse Research Labs., Pittsburgh). p.315-25 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The method utilizes a sensitive microbalance operating in an all-glass and ceramic reaction system. Equilibrium pressures are measured by the use of a sensitive McLeod gage. Studies are presented on the determination of the solubility of hydrogen in  $\alpha$ -zirconium, the range of the two phase region of the hydrogen-zirconium system, the composition and range of homogeneity of the delta and epsilon hydride phases of zirconium, and the nature of the hydrogen reaction of a 50% uranium-50% zirconium alloy. The method gives composition ranges of the single and two phase regions and thermochemical data on the heats and free energies of the reactions. (auth)

### 13005

THE SOLUBILITY OF CARBON AND STRUCTURE OF CARBIDE PHASES IN TANTALUM AND COLUMBIUM. M. L. Pochon, C. R. McKinsey, R. A. Perkins, and W. D. Forgeng (Electro Metallurgical Co., Niagara Falls, N. Y.). p.327-47 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The nature and distribution of carbide phases were studied in arc-melted tantalum and niobium alloys containing up to 3.16 and 6.5% carbon, respectively. Improved metallographic and phase isolation techniques were developed to enhance identification of the minor phases. The solid solubility of carbon is quite limited in both tantalum and niobium, and in each case, the first stable intermediate phase is of the  $\text{M}_2\text{C}$  type. X-ray data are reported for  $\text{Ta}_2\text{C}$ ,  $\text{Cb}_2\text{C}$ , and a metastable transition carbide which has been discovered in low-carbon niobium alloys. The existing tantalum-carbon and niobium-carbon constitution diagrams have been modified in accordance with the present results. (auth)

### 13006

THE SELECTION OF REACTIVE METALS FOR AIR-CRAFT NUCLEAR POWER PLANTS. A. E. Focke (General Electric Co., Cincinnati). p.379-86 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metal-

lurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The general systems available for aircraft nuclear propulsion and the major components of the direct cycle system are reviewed and described. For best performance, all components of the system are required to operate in air at relatively high temperatures. To take full advantage of "reactive" metals for these components, improved methods of providing high-temperature oxidation resistance must be developed. (auth)

### 13007

DEVELOPMENT OF VANADIUM ALLOYS FOR REACTOR APPLICATION. PART I. EVALUATION. Karl F. Smith (Argonne National Lab., Lemont, Ill.). p.403-14 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Selected vanadium-base alloys were investigated as to tensile strength, creep strength, corrosion resistance, and thermal conductivity in a preliminary evaluation of suitability for use as fuel element protective materials, particularly in sodium-cooled reactors. Results indicate excellent performance of these alloys from all viewpoints under examination and suggest the desirability of studying properties of these alloys and cheaper reduction methods for the base metal. (auth)

### 13008

DEVELOPMENT OF VANADIUM ALLOYS FOR REACTOR APPLICATION. PART II. MECHANICAL PROPERTIES. R. J. Van Thyne (Illinois Inst. of Tech., Chicago). p.415-27 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Binary and ternary vanadium-base alloys containing 2.5 to 20 wt.% titanium possess an excellent combination of properties. Tensile and stress-rupture data for wrought, arc-cast material were obtained at 650 and 800°C (1200 and 1470°F); the test specimens were protected from contamination by a helium atmosphere since the reactor environment excludes air. Mechanical properties have not been maximized, since a number of other important parameters must be considered. Alloys with a 100-hr rupture life of 68,000 and 28,000 psi at 650 and 800°C (1200 and 1470°F), respectively, have resulted. The materials are generally weldable and can be cold rolled to over 98% reduction in thickness. (auth)

### 13009

THE MECHANICAL PROPERTIES OF ARC-MELTED KROLL-PROCESS HAFNIUM. C. E. Armantrout and H. Kato (Bureau of Mines, Albany, Oreg.). p.429-38 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

Selected physical and mechanical properties of arc-melted, Kroll process hafnium are presented. They include the ultimate strength, yield strength, proportional limit, elongation, hardness, electrical resistivity, and impact strength. Other data include the effects of cold work on the tensile properties and bend radius. Properties are compared to those obtained for crystal bar hafnium processed and tested concurrently with the Kroll process material. (auth)

### 13010

EFFECT OF HYDROGEN ON TENSILE AND IMPACT

PROPERTIES OF THORIUM. David T. Peterson (Ames Lab., Ames, Iowa). p.477-85 of "Reactive Metals. Proceedings of the Third Annual Conference, Buffalo, New York, May 27-29, 1958." W. R. Clough, ed. Metallurgical Society Conferences, Volume 2. New York, Interscience Publishers, 1959.

The effect of hydrogen on the room temperature tensile properties and impact strength of Ames thorium was determined. The samples were charged with hydrogen at 800°C and tested in the slow cooled and in the quenched condition. The ductility of thorium in these tests was not reduced by small additions of hydrogen, but large concentrations of hydrogen decreased the impact values and the reduction in area of tensile samples. The 0.2% offset strength of slow cooled samples was decreased by additions of hydrogen. The quenched samples increased in hardness and offset strength with hydrogen content. Quenched samples were found to have the same ductility as slow cooled samples. (auth)

### 13011

IMPROVEMENTS IN OR RELATING TO ZIRCONIUM ALLOYS. John Nelson Wanklyn (to United Kingdom Atomic Energy Authority). British Patent 831,202. Mar. 23, 1960.

Zirconium alloys are described which have a low, stable corrosion rate. The alloys contain 1 to 5 wt. % Ta, 0.5 + 1.0 wt. % Ni and 50 to 300 ppm N<sub>2</sub>. Data are given to show the corrosion rate with time for several compositions. (T.R.H.)

## Radiation Effects

### 13012 AD-220318

Stevens Inst. of Tech., Hoboken, N. J.  
UNCLASSIFIED LITERATURE SURVEY ON THE EFFECTS OF NUCLEAR RADIATION TO ELECTRON TUBE MATERIALS. Quarterly Report No. 8 [for] Period March 1, 1959 to June 1, 1959. E. R. Johnson. 19p. SC Project No.-112B. Contract DA-36-039-SC-73146.

Thirty ceramic electron tubes were irradiated with an exposure of about 10<sup>18</sup> nvt. The tube tested was found not satisfactory for high exposure operation; the induced activity was greater than 100 R/hour at the surface of the tube. Glass receiving tubes were found to withstand nuclear radiation up to 10<sup>18</sup> nvt. The application of thin films to electronic devices operating in a radiation atmosphere is discussed. The effects of radiation on metals, magnetic materials, glass, and secondary emission are discussed. (For preceding period see AD-215580.) (C.J.G.)

### 13013 AD-229783

Quartermaster Research and Engineering Center, Natick, Mass.  
POST IRRADIATION EFFECTS: MONOMERS AND POLYMERS. Ed. F. Degering, G. J. Caldarella, and M. Mancini. Sept. 1959. 20p.

The data presented support observations that changes or reactions initiated during an irradiation exposure may continue to be operative upon the removal of the irradiation source and might be accelerated by a post-heating period. A post-irradiation effect has been demonstrated for styrene in five atmospheres, but it is more pronounced in air than it is in argon, carbon dioxide, helium, or nitrogen. The post-irradiation effects increase as the total dose increases. Cotton duck presents a more complex system but the average tensile strength in air appears to be significantly lower than that obtained in the other atmospheres. The tensile strength decreases and the loss



in weight increases as the dose rate increases, but the c-samples (post-heated at 50°C) evidenced a smaller loss in weight than did the a-samples (processed promptly) and the b-samples (refrigerated). This is attributed to an oxygen take up and to the formation of cleavage products which have a greater moisture-retention capacity. (auth)

### 13014 BMI-1425

Battelle Memorial Inst., Columbus, Ohio.

IRRADIATION-CAPSULE STUDY OF URANIUM MONOCARBIDE. Robert B. Price, David Stahl, John H. Stang, and Eugene M. Simons. Mar. 2, 1960. 41p. Contract W-7405-eng-92. OTS.

Small cylindrical specimens of enriched UC were irradiated to evaluate usefulness as a high-temperature fuel for stationary power reactors. Detailed thermal and nuclear analyses were made to arrive at an appropriate capsule design on the basis of target specimen center-line temperature (~1500°F), specimen surface temperature (1100°F), specimen composition (U-5 wt. % C), and a capsule o.d. of 1.125 in. Temperature data from thermocouples inside the capsule indicated that five of the six capsules irradiated operated at close to the design conditions. Irradiation periods for individual capsules were varied to give burnups ranging from 1,000 to 20,000 Mwd/t of U. Preliminary evidence indicates that this range of burnups was achieved. By using temperature and heat-flux data from the actual irradiations to estimate effective in-pile specimen thermal conductivities, it was found that the conductivity did not appear to vary during the exposures. (auth)

### 13015 HW-63346

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

DECONTAMINATION OF THE IRRADIATED RUPTURE PROTOTYPE WITH PEROXIDE-CARBONATE AND APACE. G. E. Neibaur and R. D. Weed. Jan. 13, 1960. 9p. Contract AT(45-1)-1350. OTS.

The Irradiated Rupture Prototype, a decontamination loop, was contaminated by dissolving irradiated uranium in 300°C water and circulating it through the loop at 1700 psi. The decontamination was effected by using a peroxide-carbonate-bicarbonate solution, an alkaline permanganate solution, and a final acid rinse of ammonium citrate. Good decontamination of stainless steel, Zircaloy-2, Inconel-X, and Monel was obtained but decontamination factors for carbon steel were relatively low (<10). It was found that carbon steel corrosion could be reduced by a factor of 4 by eliminating a galvanic couple. (C.J.G.)

### 13016 KAPL-M-CM-35

Knolls Atomic Power Lab., Schenectady, N. Y.

EFFECT OF REACTOR IRRADIATION ON JOHNSMANVILLE THERMAL INSULATION. C. Mannal. Jan. 6, 1954. Decl. Mar. 7, 1960. 15p. Contract W-31-109-Eng-52. OTS.

Two-month irradiation tests were performed on J-M Aeroflex L-K containing Si or zircon. Crushing or breaking tests showed no significant difference between irradiated and non-irradiated samples. (L.M.T.)

### 13017 NP-8478

Hughes Aircraft Co., Culver City, Calif.

COBALT RADIATION FACILITY FOR ELECTRONIC TESTING. John W. Clark and Herbert L. Wiser. Nov. 13, 1957. 7p.

The purpose of the Co<sup>60</sup> Radiation Facility is to study gamma radiation effects on operating electronic circuits and components while they are in the radiation field. The

core of the facility is a cylindrical radiation volume 2 in. in diam and 6 in. long. A cylindrical Co<sup>60</sup> source surrounding the radiation volume is composed of 500 curies of 1/8-in. by 1/4-in. pellets encapsulated in 1/8-in. by 1/4-in. brass hollow rods. The gamma radiation intensity at the center of the radiation volume was calculated to be  $4.75 \times 10^5$  roentgens/hour. (W.L.H.)

### 13018 TID-5659

Southwest Research Inst., San Antonio.

THE EFFECT OF GAMMA RADIATION ON SIMULATED LUBRICATING SYSTEMS AND COMPONENTS. Final Report. George C. Lawrason. July 13, 1959. 33p. Project 862-8. For General Electric Co. Aircraft Nuclear Propulsion Dept. Subcontract AF-81. (EE-306) OTS.

Investigations were made of the effect of gamma radiation on the performance of specific ANP engine components and a specified approved MIL-L-7808C lubricating fluid in a dynamic system, and the effect of gamma irradiation, under controlled static conditions, on the same MIL-L-7808C lubricating fluid and a MIL-L-5624D fuel. (W.L.H.)

### 13019 WAPD-208

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

IRRADIATION OF UO<sub>2</sub> FUEL RODS—THE X-1-L EXPERIMENT. J. D. Eichenberg, R. M. Lieberman, and F. P. Mrazik. Apr. 1960. 23p. Contract AT-11-1-GEN-14. OTS.

Five Zircaloy-2 clad UO<sub>2</sub> rods of PWR Core I blanket geometry were irradiated in the X-1 loop at Chalk River, Canada for 300 days, achieving a maximum burnup of 13,600 MWD/T<sub>UO2</sub> at a maximum heat flux of 310,000 Btu/hr-ft<sup>2</sup>. One of the rods contained a 0.005-in. diam artificial defect. The results of the post irradiation examination revealed that essentially no changes were produced in the general appearance or dimensions of the rods. Two of the rods were punctured and the amount of fission gas released was determined; the results indicated approximately 0.85% of the Kr<sup>85</sup> produced was released from the fuel. There was no effect of the irradiation, per se, on the microstructure of the UO<sub>2</sub>; however, grain growth was observed at the center of pellets removed from the defected rod. Some segregation of hydride was observed in the Zircaloy-2 cladding and hydrogen analyses of the cladding indicated that the amount of hydrogen absorbed by the cladding was increased over the levels expected from out-of-pile testing. (auth)

### 13020 WAPD-T-1125

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

FISSION FRAGMENT DAMAGE TO CRYSTAL STRUCTURES. R. M. Berman, M. L. Bleiberg, and W. Yeniscavich. Feb. 2, 1960. 32p. Contract AT-11-1-GEN-14. OTS.

Al<sub>2</sub>O<sub>3</sub> and ZrSiO<sub>4</sub> show little change in properties when exposed to 10<sup>18</sup> to 10<sup>19</sup> nvt of thermal neutrons. When, however, a source of fission fragments is provided in the form of a UO<sub>2</sub> dispersant, the grain boundaries and the peaks of the x-ray-diffraction profile disappear on irradiation. The crystal structure of U<sub>3</sub>O<sub>8</sub> is also destroyed when irradiated in-pile. Al<sub>2</sub>O<sub>3</sub> was observed to increase about 30% in volume concurrent with the destruction of its crystal lattice. Calculations indicate that only a small proportion of the atoms are displaced by the fission fragment through elastic collisions or other applicable mechanisms. It is suggested that the fission fragments act indirectly, through aniso-

tropic effects which distort the lattice and render it unstable. There is apparently a considerable group of materials that exhibit this property; this places a serious limitation on the materials suitable for use within the range of fission fragment recoil. In contrast to this behavior, a number of ceramic materials having a cubic crystal structure exhibit excellent stability in-pile. These materials include  $\text{UO}_2$  and  $\text{UO}_2 + \text{ZrO}_2$ . (auth)

### 13021

RADIATION DAMAGE IN CRYSTALS. L. Crabs, J. Debaisieux, D. Apers, and P. C. Capron (Univ. of Louvain, Belgium). *Bull. classe sci., Acad. roy. Belg.* (5), **45**, 891-908(1959). (In English)

Fast neutrons severely disorganize a crystal. A number of vacancies and interstitial atoms mark out the paths of the neutrons. By an analytical method based on the theory of elastic collisions (billiard ball process) the total number of atoms displaced and replaced is evaluated for a wide energy region. The generally accepted approximations are verified and the hypothetical bases discussed. The results are compared to those obtained by other workers and to experimental data from the literature. It follows that a more complete model should be proposed. The dissipation in a very small volume of a part of the energy as heat implies a greater disorder than that actually encountered. (tr-auth)

### 13022

RADIATION EFFECTS ON ELECTRONIC SYSTEMS. DESIGNING ELECTRONIC SYSTEMS FOR NUCLEAR-POWERED AIRCRAFT REQUIRES KNOWING RESPONSE OF SYSTEM COMPONENTS AND MATERIALS TO IRRADIATION. J. H. Levine and W. F. Ekern (Convair, Fort Worth, Tex.). *Electronics* **33**, No. 17, 69-70; 72(1960) Apr. 22.

Electronic components were assembled into system and tested in a radiation field in order to determine radiation effects. The relative resistance of organic and inorganic materials is given in terms of energy absorbed (ergs/gm) for gamma rays and fast neutrons/cm<sup>2</sup>. Radiation damage to electron tubes is caused largely by fracture of the metal-to-glass seal, particularly in tubes containing borosilicate glass. The irradiation data for communication-type systems are tabulated. (B.O.G.)

### 13023

THE NATURE OF THE IMPERFECTIONS OBTAINED DURING THE IRRADIATION OF AN ALLOY  $\text{Fe}_3\text{Al}$  BY  $\gamma$ -RAYS. I. Ya. Dekhtyar and A. M. Shaliev. *Inzhener.-Fiz. Zhur.*, *Akad. Nauk Belorus. S.S.R.* **3**, No. 2, 78-82 (1960) Feb. (In Russian)

Data on the effect of  $\gamma$ -radiation on the magnetic properties of  $\text{Fe}_3\text{Al}$ , Ni, and  $\text{Ni}_3\text{Mn}$  is presented. Changes in the galvanomagnetic effect and coercive force of these metals were observed. It is proposed that the change in the galvanomagnetic effect is associated with the formation of Frankel's pair defects and their subsequent relaxation. The change in the coercive force was connected with the formation of dislocation loops. (auth)

### 13024

LATTICE DISPLACEMENTS BY FAST ELECTRONS. W. Dale Compton and George W. Arnold (U. S. Naval Research Lab., Washington, D. C.). *J. Appl. Phys.* **31**, 621-5(1960) Apr.

A discussion is given of the processes by which atoms are displaced from their lattice sites by incident fast electrons. In addition to direct displacement by the inci-

dent electron, expressions are derived for the fraction of atoms displaced by fast moving atoms and by fast secondary electrons, both of which are generated initially by the incident electron. A discussion of thermal spikes is given. A thermal spike process is discussed that might lead to the generation of defects with x irradiation in materials that exhibit a threshold energy for a displacement by a charged particle. (auth)

### 13025

HEATING IN LIQUID HELIUM RESULTING FROM NEUTRON AND GAMMA BOMBARDMENT BY A FISSION SOURCE. M. G. Chasanov (IBM Corp., Owego, N. Y.). *J. Appl. Phys.* **31**, 733-4(1960) Apr.

The effects of radiation environment on a coolant such as liquid helium were investigated. The mechanisms in which neutrons and gamma rays passing through the helium dissipate a portion of their energies as heat are discussed. The energies lost are from neutron scattering, gamma absorption, and the  $\text{He}^3(n,p)$  reaction. The absence of  $(n,\gamma)$  reactions for helium eliminates a large source of heat. Equations are given for the heat and time required to vaporize liquid helium. (B.O.G.)

### 13026

GAMMA-RAY INDUCED CONDUCTIVITY IN POLYETHYLENE COAXIAL CABLE. Kichinosuke Yahagi and Akibumi Danno (Japan Atomic Energy Research Inst., Tokyo). *J. Appl. Phys.* **31**, 734-5(1960) Apr.

The electrical conductivity changes in a 3C-2V-type polyethylene high-frequency coaxial cable are reported for conditions of high dose rates of gamma radiation. The dose rates ranged from  $4.2 \times 10^5$  to  $1 \times 10^6$  r/hr and potentials of 0 to 1000 v at currents of  $10^{-11}$  to  $10^{-9}$  amp. Relations between the induced currents and dose rates give straight lines of slope 0.68 except for zero voltage. The direction of the current for  $V = 0$  is reversed to that for the voltage supply, resulting in a greater value for the slope. (B.O.G.)

### 13027

RADIATION CROSSLINKING OF RUBBER. III. CHAIN FRACTURE. L. Mullins and D. T. Turner (British Rubber Producers' Research Assn., Welwyn Garden City, Herts., Eng.). *J. Polymer Sci.* **43**, 35-47(1960) Mar.

Purified natural rubber was exposed *in vacuo* to a 4-Mev electron beam and attempts were made to estimate the ratio of fractures of the main chain of carbon atoms to crosslinks, using three different methods. Measurements of the sol fraction (S) as a function of the radiation dose (R) did not conform to a linear relationship between  $S + S^{1/2}$  and  $R^{-1}$  reported by Charlesby and Pinner for a number of other polymers. Little consummated random fracture appeared and the sol fraction tended toward zero at radiation doses above about 50 Mrad. The stress in rubbers maintained at constant elongation decreased continuously on irradiation, and rigorous exclusion of traces of air and impurities was of critical importance. Deficiencies of previous analyses of stress-relaxation data are discussed and an attempt made to provide an internally consistent treatment of the data. A value for  $\beta$  of 0.18 was obtained when no allowance was made for chain entanglements, a value of 0.03 was obtained when such allowance was made. This very low value may be due to the inadequacy of the assumption made that fracture releases entanglements. In a third method stress-strain measurements of irradiated rubber provided estimates of the number-average molecular weights of both the chain segments between adjacent crosslinks and the primary molecular chains. Comparison with similar data for vulcanizates prepared by thermal decom-



position of di-tert-butyl peroxide gave a value for  $\beta$  of 0.11. This value was calculated on the assumption that no fracture occurs on formation of the peroxide vulcanizates. The nominal  $G(X)$  value of 0.9 is increased to 1.05 when an allowance is made for fracture. (auth)

### 13028

**VULCANIZATION OF BUTADIENE/STYRENE RUBBER IN A THERMAL NEUTRON FIELD.** Herbert R. Anderson, Jr. (Phillips Petroleum Co., Bartlesville, Okla.). J. Polymer Sci. **43**, 59-69(1960) Mar.

Vulcanization of butadiene/styrene rubber in a thermal neutron field is described. Tread type vulcanization produced from highly ionizing particles resulting from the nuclear reactions  $B^{10}(n,\alpha)Li^{1*}$  and  $Li^6(n,\alpha)H^3$  have negligible residual radioactivity and possess physical properties comparable with those produced by other means, e.g., gamma rays and peroxides. Swelling and stress-strain properties indicate that the response of the tread type compound to analogous nuclear reactions have pronounced differences. The vulcanizates also differ markedly. Values of  $G$  of the tread-type compound in a helium atmosphere were found to have an average value of 3 for promotion by lithium methoxide and 0.9 in the case of boron nitride. Such values decrease 30% with lithium methoxide promotion and increase by a factor of 2 for boron nitride promotion when air is substituted for helium. (auth)

### 13029

**THE EFFECT OF GAMMA RADIATION ON AIRCRAFT INSTRUMENT LUBRICATING OILS.** William L. R. Rice (Wright Air Development Center, Wright-Patterson AFB, Ohio). Lubrication Eng. **16**, 157-60(1960) Apr.

An evaluation is given of the effects of gamma radiation on three aircraft instrument lubricating oils. Changes in the physical and chemical properties are shown as a function of increasing gamma exposure. Empirical equations are derived relating some of the observed property changes to the magnitude of the gamma dose. Based on the property changes of the fluids, particularly at the higher dose levels, it appears that their use in a radiation environment would be questionable. Verification of fluid limitations through in-source evaluation in dynamic tests is necessary. (auth)

### 13030

**CHANGES IN MATERIAL PROPERTIES INDUCED BY CORPUSCULAR AND PHOTON RADIATION.** K. Sagel. Metall. **12**, 353-63(1958) May. (In German)

The interactions between corpuscular radiation and lattice structure of solids are of two types: in the case of elastic interaction, the corpuscles transfer kinetic energy to the lattice elements causing "thermal spikes" and Frenkel defects, while the inelastic interaction causes ionization or excited states. Gamma or x rays produce lattice defects and dislocations which lead to structural changes in metals and alloys. These changes modify the physical characteristics of metals and alloys such as specific weight, electric resistance, magnetic susceptibility, hardness, and tensile strength. In the case of neutron bombardment, the changes, which depend on the dose and the temperature, become more pronounced with increasing dose and decreasing temperature. As far as organic substances are concerned, the effects of  $\gamma$ ,  $x$ , and  $\beta$  rays or neutrons depend largely upon the absorbed energy/g of the substance. The effects of either corpuscular or photon radiation can produce the breaking of chemical bonds and the formation of free radicals, and dissociation and rearrangements of molecules. In partic-

ular, the following effects were observed: gas formation, interlacing, polymerization, degradation, oxidation, radical formation, and changes in physical properties. (OD)

### 13031

**RADIATION DAMAGE IN IRON AND STEEL-2.** D. R. Harries (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Power **5**, No. 48, 142-5(1960) Apr.

A survey is given of recent research on radiation damage in iron and steel. All results described, except the creep tests which were conducted "in pile," were obtained by testing "out-of-pile" after completion of irradiation. It was established that irradiation of steels, in common with other metals and alloys, results in increases in yield strength and, to a lesser extent, in ultimate tensile strength and reductions in the capacity for work-hardening and in uniform elongation. These changes are much more severe in ferritic steels than in austenitic steels. (B.O.G.)

### 13032

**NEUTRON-IRRADIATION EFFECTS IN COPPER-ALUMINUM ALLOYS.** A. C. Damask and C. J. Dienes (Brookhaven National Lab., Upton, N. Y.). Phys. and Chem. Solids **12**, 105-6(1959) Dec.

Experimental data on the decrease of electrical resistivity in Cu-Zn alloys upon neutron irradiation are interpreted in terms of diffusion leading to increased short-range order. Wechsler and Kernohan's interpretation of comparable data on Cu-Al alloys in terms of annealing of excess vacancies is confuted. (D.L.C.)

### 13033

**REPLY TO THE LETTER OF DAMASK AND DIENES ON "NEUTRON-IRRADIATION EFFECT IN COPPER-ALUMINUM ALLOYS."** M. S. Wechsler and R. H. Kernohan (Oak Ridge National Lab., Tenn.). Phys. and Chem. Solids **12**, 107-9(1959) Dec.

Reasoning in favor of the vacancy-annealing theory and against the short-range order theory of neutron irradiation effects in Cu-Al and Cu-Zn alloys is presented. It is concluded that the question of why the resistance of the alloys decreases with neutron irradiation is still unsettled. (D.L.C.)

### 13034

**THRESHOLD MEASUREMENTS AND THE PRODUCTION OF RADIATION DAMAGE IN THE NOBLE METALS.** J. W. Corbett and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. **117**, 970-71(1960) Feb. 15.

The electrical resistivity changes induced by bombarding Cu, Ag, and Au at  $\sim 10^4$ K with 1.5-Mev electrons were measured. It is inferred that the threshold energy  $T_d$  for radiation damage production in Cu, Ag, and Au is 22, 30, and  $\geq 40$  ev, respectively. The fact that the  $T_d$  values are not the same for this homologous series of metals requires reconsideration of the comparison of deuteron radiation damage theory and experiment. This shows that even beyond the different  $T_d$  values, the damage process parameters in these materials are not identical. (auth)

### 13035

**EFFECTS OF FAST-NEUTRON IRRADIATION ON NICKEL THIN FILMS.** I. Teodorescu and A. Glodeanu (Inst. for Atomic Physics, Bucharest). Phys. Rev. Letters **4**, 231-2 (1960) Mar. 1.

Thin films of nickel were irradiated by fast neutrons at 45 and 59°C to  $3.38 \times 10^{17}$  and  $9.45 \times 10^{18}$  nvt, respectively. As a result of fast-neutron irradiation to  $3.38 \times 10^{17}$  nvt,

films of nickel were transformed from face-centered cubic to close-packed hexagonal lattices with  $a = 2.62$  Å and  $c = 4.36$  Å. For samples irradiated to  $9.45 \times 10^{15}$  nvt, both face-centered cubic and close-packed hexagonal lattices were obtained. For samples transformed into close-packed hexagonal lattices, the magnetic properties disappeared and the coercive force fell from  $H_c = 240$  to  $H_c = 0$  oersted. The samples in which part transformed into hexagonal lattices showed a drop in magnetization of about 30 to 50% and their coercive force increased to a certain extent. Samples irradiated in oxygen revealed a more ordered structure after irradiation with the hysteresis cycle more rounded. (C.J.G.)

### 13036

THE EFFECT OF  $\gamma$ -IRRADIATION ON POLYVINYL CHLORIDE FIBERS. [PART] I. Motoo Takayanagi, Teruo Aramaki, and Tsuyoshi Konomi. Sen-i Gakkaishi **15**, No. 2, 124-8(1959) Feb. (In Japanese)

The physical properties of polyvinyl chloride fibers, including density, breaking strength, breaking elongation, viscosity, and thermal shrinkage were measured for samples which had been subjected to  $\text{Co}^{60}$   $\gamma$  radiation in a vacuum at room temperature. The radiation doses ranged from 0 to  $3 \times 10^7$  r. The breaking strength decreased with increasing dosage, but the effect of irradiation was not detected in densities or in breaking elongations. The degree of polymerization, which was estimated from viscosity measurements, decreased with irradiation at lower dosages, but it tended to rise at higher dosages. The effects of irradiation on the thermal shrinkage became visible only in the higher temperature range. Both the nonirradiated and the low irradiated specimens ultimately were broken because the flow of the molecular chains was accelerated by the rising temperature after showing the maximum contraction at their melting temperature ( $180 \sim 190^\circ\text{C}$ ). The higher the radiation dosage, the greater the flow of the molecular chains at lower temperatures, corresponding to the chain scission caused by irradiation, while for the drastically irradiated specimens, the flow stopped at about  $260^\circ\text{C}$  and at the same time the fibers began to shrink. (OID)

### 13037

DIELECTRIC PROPERTIES OF  $\gamma$ -RAY IRRADIATED METHYL-METHACRYLATE AND POLYMETHYL-METHACRYLATE. Yoshio Inuishi, Hiroshi Sumitomo, and Kimihiko Hayata. Technol. Repts. Osaka Univ. **8**, 243-51(1958) Oct. (In English)

A methylmethacrylate (MMA) monomer was polymerized by  $\text{Co}^{60}$   $\gamma$  irradiation. The breakdown strength of the monomer increased abruptly at the dosage where transition from the liquid monomer to the solid polymer occurred. Voltage measurement of a d-c current showed that the conduction is mainly of an ionic nature before breakdown and then results in sudden current multiplication. Polymethylmethacrylate resin, when irradiated with  $\gamma$  rays from a  $\text{Co}^{60}$  source at a dosage of  $4 \times 10^7$  r, degrades to a polymer of smaller mean molecular weight. The d-c and impulse breakdown strengths decrease, and the conduction current is reduced. The lowering of d-c breakdown voltage is the result of increased ionic space charge. The lowering of impulse breakdown strength necessitates an electronic model. (OID)

### 13038

INVESTIGATIONS WITH NEUTRONS AT VERY LOW TEMPERATURES. Martin Nöbauer and Fritz Schmelssner (Bayerische Akademie der Wissenschaften, Herrsching a.

Ammer, Ger.). Z. angew. Phys. **12**, 133-42(1960) Mar. (In German)

A survey is given of the investigations made with neutrons at very low temperatures. The studies can be divided into the following groups: reactions of aligned nuclei with polarized and unpolarized neutrons, production of slow neutrons, diffraction experiments in liquid helium, scattering experiments on superconductors, magnetic investigations by neutron diffraction, and investigations on radio-induced structure faults in solids. 48 references. (J.S.R.)

### 13039

A STUDY OF THE CHANGE IN THE PROPERTIES OF POLYMERS BY IRRADIATION. Kenichi Shinohara, et al. p.131-6 of "Aisotōpu Kenkyū Riyō Sōran, 1956." Tokyo, Japan Atomic Energy Industrial Association, 1957. (In Japanese)

When polyethylene is irradiated with deuterons,  $\gamma$  rays, or in a reactor, a network film forms which does not melt at temperatures higher than  $300^\circ\text{C}$ . Irradiated polyvinyl alcohol (PVA) forms a network film which does not soften at temperatures higher than  $275^\circ\text{C}$  or dissolve in organic solvents. The network did not form in irradiated PVA unless thermal treatment was given after irradiation. PVA is weak when heated or in water, but irradiated PVA will not melt or dissolve in hot water at  $150^\circ\text{C}$  or higher. (OID)

### 13040

IMPROVED IRRADIATED POLYETHYLENE. (to General Electric Co.). British Patent 830,899. Mar. 23, 1960.

An irradiated polyethylene stabilized to high-temperature oxidation by sym-di- $\beta$ -naphthyl-p-phenylenediamine (DNPPD) and its preparation are described. In an example, samples of solid polyethylene DYNH (m.w. = 21,000) were compounded with 0.5 wt. % of various antioxidants including DNPPD and molded in sheets and irradiated to  $15 \times 10^6$  r with high-energy electrons. The samples were compared by measuring the power factors at 1 megacycle in air at  $150^\circ\text{C}$  until failure. The power factors for all samples at the beginning were 0.001 and ranged from 0.002 for the sample with the preferred stabilizer to 0.04 for one of the others. Thus the preferred stabilizer maintains the oxidation resistance at a higher level for a longer period of time. (T.R.H.)

### 13041

STABLE IRRADIATED POLYETHYLENE. (to General Electric Co.). British Patent 831,257. Mar. 23, 1960.

An irradiation apparatus, an irradiation-annealing process, and an ethylene polymer with greater stability are described. An electron accelerator is used for the irradiation. In an example, high-density polyethylene was irradiated at  $25^\circ\text{C}$  to  $15 \times 10^6$  rep and annealed at  $130^\circ\text{C}$ . After annealing, the percent elongation was measured from time to time over a period of 128 days and compared with an unannealed sample. The stability of the annealed sample was excellent. It is supposed that annealing releases trapped free radicals and prevents oxidation. (T.R.H.)

## PHYSICS

### General and Miscellaneous

#### 13042 AERE-R-3225

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.



THE OPTICAL SPECTRA OF SOME RARE EARTH AND TRANSURANIC ELEMENTS IN THE 1-3 MICRON REGION. PART V. THE SPECTRUM OF LUTETIUM. L. Bovey, E. B. M. Steers, and H. S. Wise. Feb. 1960. 11p. BIS.

A list of the wavelengths and intensities for lutetium lines is given together with a discussion of the experimental technique. The relation between the results and the assignment of known levels to electronic configuration is briefly noted and levels involved in a transition when known have been added to the table of lines. (auth)

#### 13043 AFBMD-TR-60-22

Avco Corp. Avco-Everett Research Lab., Everett, Mass. OXYGEN VIBRATION AND DISSOCIATION RATES IN OXYGEN-ARGON MIXTURES. Research Report No. 84. M. Camac and A. Vaughan. Dec. 1959. 84p. Contracts AF04(647)-278 and DA-19-020-ORD-4862.

Experimental measurements of vibration and dissociation relaxation of  $O_2$  in  $O_2$ -Ar mixtures were obtained from 1200 to 8000°K. The measured vibrational relaxation time is in excellent agreement with theoretical predictions.  $O_2$  is five times more efficient than argon for producing  $O_2$  vibrational relaxation. The  $O_2$  dissociation energy  $D = 5.116$  ev. This result is compared to the classical collision theory. The rates for the dissociation of  $O_2$  by  $O_2$  or O are compared to  $k_{Ar}$ :  $k_O = 18 k_{Ar}$ ;  $k_{O_2} \leq 3 k_{Ar}$ . The vibration and dissociation relaxation rates become comparable at about 8000°K temperature. The experimental data indicates that there is at least a factor of 2 decrease in the dissociation rate at high temperatures (above 8000°K) where the vibration is not in equilibrium. (auth)

#### 13044 AFCRC-TN-59-620

University of Western Ontario, London. Molecular Excitation Group.

SHOCK TUBE SPECTROSCOPY. I. THE SHOCK EXCITATION OF POWDERED SOLIDS. Scientific Report No. 1. W. H. Parkinson and R. W. Nicholls. July 15, 1959. 101p. Contract AF19(604)-4560. (AD-228877).

Research is reported which involves studies of shock wave interactions with powdered solids. Helium driven shock waves in argon were used to excite a number of astrophysically important oxides (CuO, BeO, MgO, CaO, SrO, BaO,  $H_3BO_3$ ,  $Al_2O_3$ ,  $TiO_2$ , PbO,  $Pb_3O_4$ ,  $V_2O_5$ ,  $Cr_2O_3$ ,  $H_2WO_4$ ,  $\alpha$ - $Fe_2O_3$ ,  $Fe_3O_4$ ,  $FeTiO_3$ ). In addition to the metallic oxides some hydride compounds (Al + H, CuH) and carbon and cyanide compounds (C, AgCN,  $K_3Fe(CN)_6$ ,  $K_3Co(CN)_6$ , KCN) were also studied. As an application to meteor physics four samples of meteorite were subjected to shock excitation. Time resolved emission and absorption spectra of BeO, TiO, and VC were obtained and it is believed that the BeO and  $\alpha$ -TiO bands represent the first laboratory record of these bands in absorption. Unusual color and physical changes, indicating severe ablation, were observed upon the surfaces of several of the shock treated powder particles. Microscopic chemical and x ray techniques were applied where possible to study the physical and chemical changes. The type of spectrum (atomic or molecular) excited in the shock tube can be selected and restricted by suitably adjusting the Mach number (or gas temperature) through the initial pressure ratio and gas parameters. Generally, therefore, for a specific powdered compound there is a critical shock temperature which excites an entirely molecular spectrum, a higher shock temperature which produces a combination of molecular and atomic spectra, and finally a high shock temperature which results in a completely atomic spectrum. The combined results from the spectroscopic time resolved and microscopic experiments suggested that an atomic vapor

is ablated from the powder particles and excited thermally to luminosity by the argon atom behind the reflected shock wave. This is followed by recombination of the ablated atom to form molecules which emit the characteristic band spectrum. Finally as the temperature decreases the vapor condenses on the surfaces of the original powder grains often with the formation of new compounds. (auth)

#### 13045 AFCRC-TN-59-622

University of Western Ontario, London. Molecular Excitation Group.

SHOCK TUBE SPECTROSCOPY. II. SPECTROSCOPIC TEMPERATURE AND INTENSITY MEASUREMENTS IN A SHOCK TUBE. Scientific Report No. 3. W. H. Parkinson and R. W. Nicholls. Aug. 15, 1959. 46p. Contract AF19(604)-4560. (AD-228879).

Spectroscopic rotational temperature measurements on the (0,1) band of the CN violet system gave temperatures which agree with the calculated gas kinetic temperature to about 10%. This method provided a means of inferring a temperature without introducing temperature sensitive devices such as probes in the environment. Rotational intensity measurements on the (0,0) Aln band of the  $A^1n-X^1\Sigma^+$  system revealed an unusual intensity anomaly which is very pressure sensitive. Experiments in the shock tube at high pressure (7 to 13 atmospheres) and in a discharge tube at low pressure (less than one atmosphere) suggested the presence of pressure sensitive strength factors rather than the usual strength factors, or pressure induced predissociation of the excited  $^1n$  state by a postulated  $^3\Sigma$  state according to the Xronig selection rules. Similar measurements with the Curi (0,0) band ( $^1\Sigma^+-^1\Sigma^+$ ) showed that rotational equilibrium is not obtained with this molecule. Time resolved intensity measurements at several pressures indicated that the non-equilibrium condition is due to a forbidden predissociation of the excited  $^1\Sigma^+$  state to a  $^3\Sigma^+$  state. (auth)

#### 13046 APEX-527

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati.

DATA BOOK—PHYSICAL PROPERTIES AND FLOW CHARACTERISTICS OF AIR. J. L. Hobbs and M. E. Lapidus. Mar. 1956. 59p. Contracts AF33(600)-38062 and AT(11-1)-171. OTS.

#### 13047 GAT-T-579(Rev.1)

Goodyear Atomic Corp., Portsmouth, Ohio.

RELATIONSHIPS BETWEEN GAMMA RADIATION READINGS AND CERTAIN VARIABLES FOR URANIUM OXIDES AND URANIUM SALTS. J. L. Feuerbacher. Feb. 15, 1960. 20p. Contract AT(33-2)-1. OTS.

Results of a study on gamma radiation from uranium materials are presented. Attention was directed to the effects of a number of variables on radiation measurements. Definite relationships were found to exist between radiation readings and deposit thickness, distance, isotopic masses, and enrichment. It was also noted that radiation can be related to the solid angle subtended by the deposit at the meter probe. Effects of the presence of  $UF_6$  gas can be estimated. (J.R.D.)

#### 13048 HW-27921

Hanford [Atomic Products Operation], General Electric Co. Richland, Wash.

PHYSICS UNIT—APPLIED RESEARCH SUBSECTION TECHNICAL ACTIVITIES REPORT FOR APRIL 1953. J. E. Faulkner, D. E. Davenport, and G. E. Duvall.

May 4, 1953. Decl. Mar. 3, 1960. 15p. OTS.

The  $\beta$  spectra of  $Ti^{204}$  and  $Rh^{106}$  were determined. The

results of neutron streaming calculations for Hanford graphite are reported. Buckling measurements on a  $6\frac{3}{16}$  in. small slug lattice were completed. Critical lattice experiments and neutron distribution studies are also reported. (D.E.B.)

**13049** HW-32672

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

THE RESONANCE ESCAPE PROBABILITY OF THORIUM SLUGS. G. W. Stuart, Jr., and R. K. Cole. Aug. 5, 1954. Decl. Feb. 6, 1956. 3p. OTS.

The resonance escape probability for a Hanford-size solid Th slug is analyzed. (J.E.D.)

**13050** HW-60781

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

PROGRAM ON THE IBM 709 DIGITAL COMPUTER OF THE  $P_3$  APPROXIMATION TO THE BOLTZMANN TRANSPORT EQUATION IN CYLINDRICAL GEOMETRY. Donna D. Matsumoto and Clifford R. Richey. June 17, 1959. 34p. Contract AT(45-1)-1350. OTS.

The approximate solution to the neutron transport equation in cylindrical geometry was programmed for the IBM-709 by use of the Fortran II coding system. A discussion of the  $P_3$  method and program is given. An example case is calculated and the results are presented. (W.D.M.)

**13051** IS-67

Ames Lab., Ames, Iowa.

NOTE ON THE DETERMINATION OF THE MAGNETORESISTANCE TENSOR OF A CRYSTAL HAVING THE SYMMETRY  $O_H$  OR  $O$ . Toshihiro Okada. Jan. 1960. 16p. Contract W-7405-eng-82. OTS.

In order to obtain information about the band structure of conduction electrons or holes, it is often desirable to measure the magnetoresistance effect. A practical method is described for the determination of the three components of the magnetoresistance tensor for crystals having the point group symmetry  $O_H$  or  $O$ . The method is most convenient for cleavage planes (100), (110), or (111). (W.D.M.)

**13052** JPL-PR-30-15

California Inst. of Tech., Pasadena. Jet Propulsion Lab. THE LIOUVILLE EQUATION FOR A WEAKLY INTERACTING QUANTUM GAS POSSESSING INTERNAL DEGREES OF FREEDOM. Oldwig von Roos and Richard Osborn. Sept. 15, 1959. 26p. Contract NASw-6.

The quantum-mechanical Liouville Equation of a distribution function is derived for gas systems having subsystems or species. Internal degrees of freedom, symmetry considerations, strong and weak interaction of subsystems, and the distribution function and Liouville equation to those derived previously for structureless point particles are taken into account. (auth)

**13053** LAMS-2248

Los Alamos Scientific Lab., N. Mex.

DESIGN AND TESTING OF LENS SYSTEMS. F. A. Lucy. Sept. 1958. 184p. Contract W-7405-eng-36. OTS.

An intermediate text and reference work for the design and testing of moderately complex lens systems is presented. Basic concepts are introduced very sketchily by way of establishing notation and providing a compact reference. Considerations particularly useful in setting up or selecting lens design and testing methods are developed in fairly full detail. A short bibliography is added as a key to further information. Accessibility of automatic computing machinery is presupposed, and a set of code sheets for lens design on the IBM card-programmed calculator is ap-

ended. The methods described can be adapted to other machines. (auth)

**13054** LMSD-3123-R1

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

THERMAL STRESS ANALYSIS BY ENERGY METHODS. Louis A. Riedinger. June 1958. 30p.

An energy concept was employed to analyze thermal stresses in a structure subjected to temperature variation. After structural idealization, the application of redundants between the specified adjacent structural elements, the temperature of each element was applied. With the redundants missing, each element freely expanded; however, the confinements generating thermal stress were calculated by use of Castigliano's minimal energy theorem. Temperature stresses due to dissimilar materials were calculated by this method. Various materials were combined in an attempt to reduce the thermal stress. The  $\alpha\Delta T$  product of the various members was studied. The energy method was applied to a truss and to a flat plate. (auth)

**13055** LS-37

Israel. Atomic Energy Commission, Tel-Aviv.

LITERATURE SURVEY ON AUTORADIOGRAPHY WITH NUCLEAR EMULSION TECHNIQUES FOR QUANTITATIVE MEASUREMENTS FOR ALPHA, BETA AND GAMMA RADIATION IN BIOLOGICAL SAMPLES. Apr. 1959. 8p.

A bibliography is presented on autoradiography with nuclear emulsion techniques for quantitative measurements for  $\alpha$ ,  $\beta$ , and  $\gamma$  radiation in biological materials. The references were compiled from other bibliographies and Nuclear Science Abstracts 1948 through 1958. 69 references. (T.R.H.)

**13056** LS-58

Israel. Atomic Energy Commission, Tel-Aviv.

LITERATURE SURVEY ON PRODUCTION OF TRITIUM. Aug. 1959. 4p.

A bibliography is presented on tritium production. The sources of information used were Nuclear Science Abstracts 1948-1959 (issue No. 10) and Physical Review 1959 (Nos. 1-6). 29 references. (T.R.H.)

**13057** NAA-SR-4694

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

AIM-5—A MULTIGROUP, ONE-DIMENSIONAL DIFFUSION EQUATION CODE. H. P. Flatt and D. C. Baller. Appendix by E. R. Cohen. Mar. 1, 1960. 58p. Contract AT-11-1-GEN-8. OTS.

A description is given of a general multigroup, one-dimensional diffusion equation code written in FORTRAN. Options included in the code are five different criticality searches, calculation of the adjoint flux, and the computation of an initial guess for a FORTRAN SNG code. (auth)

**13058** ORNL-2884

Oak Ridge National Lab., Tenn.

FOCUSING PROPERTIES OF INHOMOGENEOUS MAGNETIC SECTOR FIELDS. M. M. Bretscher. Apr. 20, 1960. 52p. Contract W-7405-eng-26. OTS.

An investigation was made of the focusing properties of axially symmetric inhomogeneous magnetic sector fields with arbitrary circular boundaries. In first-order approximation the field was assumed to vary as  $r^{-n}$  ( $0 \leq n < 1$ ). The equations of motion for the ion trajectories are developed from a least-action principle and solved through second-order approximation. Suitable expressions are derived for the horizontal and vertical



focus positions, which are located outside the field boundaries. The mass dispersion and resolving power are found to vary as  $(1-n)^{-1}$  and so are considerably increased over the corresponding values for the homogeneous field ( $n = 0$ ). Expressions for the second-order radial and vertical aberrations are derived. It is shown that the second-order radial aberration may be eliminated by proper shaping of the magnetic field and/or field boundaries. An equation is developed for the profile of the pole faces required to produce the desired field. The results are modified to account for the defocusing action of the magnetic fringing field. A numerical example is presented for a symmetrical spectrometer having a  $90^\circ$  sector field with  $n = 1/2$ . For this case, simultaneous double directional and second-order radial focusing are shown to be possible. (auth)

13059 ORNL-2891

Oak Ridge National Lab., Tenn.

AN EVALUATION OF SOLID MODERATING MATERIALS.

T. S. Lundy and E. E. Gross. Apr. 25, 1960. 12p.

Contract W-7405-eng-26. OTS.

Calculations of moderating ratio and neutron age were used to evaluate potential solid moderators for nuclear applications. Desirable moderators have large moderating ratios and small neutron ages. Only materials that were stable solids at  $300^\circ\text{C}$  were considered. The minimum moderating ratio was taken as 20, and the maximum fission-to-thermal neutron age was set at  $500\text{ cm}^2$ . Moderating ratios and neutron ages were calculated for many materials. Twelve hydrides and five nonhydrides were found that met the criteria. In general, the hydrides have low moderating ratios and neutron age values, whereas the nonhydrides have high values for both these nuclear properties. (auth)

13060 ORNL-2910

Oak Ridge National Lab., Tenn.

PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING FEBRUARY 10, 1960. Apr. 4, 1960.

102p. Contract W-7405-eng-26. OTS.

The existence of pseudoscalar interaction in beta decay is investigated by comparing the theoretical calculation with the experimental data on the  $\text{Pr}^{144} 0 \rightarrow 0$  (yes) beta transition. An upper limit on  $|C_P/MC_A|$  was set as 0.05. Arguments are given from the experimental information on the nucleon form factors to make plausible the assumption that a major breakdown of conventional space-time concepts occurs at distances comparable with the experimental nucleon radii. A Woods-Saxon potential with a state dependent depth was found which reproduces the single-particle states of  $\text{O}^{17}$ . The effective mass formalism for the velocity dependence was investigated. The longitudinal polarization of 618-kev betas from the decay of  $\text{P}^{32}$  was measured by Mott scattering to be  $(-0.981 \pm 0.012)v/c$ . The angular correlation for the 0.60-0.60-Mev gamma-ray cascade in  $\text{Ge}^{74}$  was measured. The cascade was found to have the spin sequence  $2(D + Q)2(Q)0$  with  $Q/D = 12 \pm 7^{17}$ . Coulomb excitation results on 14 even-even nuclei of Ni, Zn, Ge, and Se are reported. The gamma-ray spectrum of  $\text{I}^{132}$  was studied with scintillation spectrometers. A tentative decay scheme is proposed. The singles and coincident gamma-ray spectra from the decay of  $\text{Rh}^{102}$  were measured with scintillation spectrometers. The branching ratio of cascade to cross-over from the second  $2^+$  state is  $1.5 \pm 0.3$ , and  $E_2/M1$  for the  $2^+ \rightarrow 2^+$  transition is greater than or equal to 225. Cross sections averaged over resonances for (p,n) reactions in 31 intermediate-weight ( $37 \leq A \leq 133$ ) nuclei were measured for proton energies from 1.5 to 5.5 Mev. The

total neutron cross section of normal lead and of an effectively 72%  $\text{Pb}^{208}$  sample of lead was measured from 1 to 4.1 Mev, and the differential neutron scattering cross sections for these samples were determined at 1.2, 2.2, and 3.2 Mev. Automation and punched-tape output have made it possible to carry on the routine total cross section measurements while permitting time for other types of measurements. The isotopes  $\text{Ge}^{70}$ ,  $\text{Ge}^{72}$ ,  $\text{Ge}^{74}$ , and  $\text{Ge}^{76}$  were studied with 2% or better energy resolution from 3 to 30 kev. Cobalt-59 and  $\text{Cu}^{63}$  were examined at 3 to 10 kev and new structure found. Neutron radiative capture cross section measurements were made with a new large-volume liquid scintillator recently installed at the ORNL fast-chopper time-of-flight neutron spectrometer. Data were obtained in the low kev region, where the resolution averages over many resonances; and also in the 10 to 200 ev range, where individual resonances were resolved. The variation with neutron energy of the total cross section of  $\text{U}^{233}$  was measured up to 100 ev. The data up to 5 ev were analyzed using a multilevel-multichannel formula. Having exhausted most of the Zeeman data available for Er II, an extension of the present energy level system was attempted using existing wavelength data and the aid of the IBM-704 computer. This attempt verifies the statistical behavior of this method of using wavelength data, and also demonstrates the need for more wavelength data. Preliminary data and analysis of the hyperfine structure and isotope shift of  $\text{Po}^{209}$  are presented. Patterns are reported for 21 lines, and structures are presented for seven energy levels of  $\text{Po}^{209}$ . These preliminary results suggest the correctness of Mrozowski's identification of the lines  $\lambda 5939.6$  and  $\lambda 4611.5$ . Infrared spectra of solid  $\text{NH}_3$ ,  $\text{NH}_2\text{D}$ ,  $\text{NHD}_2$ , and  $\text{ND}_3$  in the stable cubic phase and in two metastable phases are discussed. Molybdenum trifluoride,  $\text{MoF}_3$ , becomes antiferromagnetic below  $185^\circ\text{K}$  with a spin-only magnetic moment corresponding to  $S = 3/2$  and a magnetic structure which can be correlated with coupling rules applicable to the iron-group trifluorides. These results, together with the absence of observable magnetic neutron scattering from  $\text{PdF}_3$  and  $\text{RuF}_3$ , suggest that Hund's rule does not apply to ions in the 4d transition series. An experimental determination of the signs of the quadrupole and hyperfine coupling constants leading to nuclear alignment in  $\text{NpO}_2^{++}$  has shown that the original assignments of Eisenstein and Pryce ( $A > 0$ ,  $P < 0$ ) were incorrect. The fission of oriented  $\text{U}^{233}$  was found to be isotropic, while  $\text{U}^{235}$  showed an anisotropy opposite to that of its alpha particles. A comparison with the predictions of the Bohr picture is made. Relativistic Hartree wave functions for atomic uranium and  $\text{U}^{5+}$  were calculated. By use of these a discussion of the nuclear quadrupole coupling in  $\text{UO}_2^{++}$  and  $\text{NpO}_2^{++}$  is given. A better understanding of the very low temperature behavior of semiconductor surface barrier counters was obtained. Construction of a source of polarized ions is under way. A status report and description of the apparatus are given. A study of the aberrations in electrostatic lenses is presented. A zero-spherical-aberration arrangement is shown feasible if a shaped wire grid is used in the cross section of the beam. This is not possible with conventional two-element lenses. (For preceding period see ORNL-2718.) (W.D.M.)

13061 RM-2275(RAND)

RAND Corp., Santa Monica, Calif.

RECENT RESULTS OF HIGH ALTITUDE RESEARCH BY MEANS OF ROCKETS AND SATELLITES. H. K. Kallmann. Aug. 28, 1958. 31p. (AD-207200).

A review is given of the results of high-altitude research conducted by rockets and satellites on air densities,

chemical composition, ion composition, electron densities, ultraviolet and x radiation, and energetic particles in the upper atmosphere. (C.J.G.)

**13062** SCTM-242-54(51)

Sandia Corp., Albuquerque, N. Mex.

A PHOTOGRAPHIC STUDY OF SOURCES OF SPHERICAL SHOCK WAVES. J. Todd, Jr. Nov. 16, 1954. 8p. OTS.

A photographic study of  $\frac{1}{2}$ -ounce charges showed that composition B is unsuited to small-scale work but that 50-50 pentolite is satisfactory. Special seismic and No. 8 Western Cartridge Company blasting caps are unsatisfactory as sources of spherical waves. Exploding wires produce nearly spherical shocks at a radius of 6 to 8 inches. (auth)

**13063** SCR-5

Sandia Corp., Albuquerque, N. Mex.

SOME PROPOSED RESEARCH ACTIVITIES PERTAINING TO RELIABILITY. R. O. Frantik. SOME NOTES ON THE ESTIMATION OF RELIABILITY. R. L. Calvert. Feb. 1958. 26p. OTS.

The portion of this report by R. O. Frantik is a rewritten version of AECU-3354.

An outline of the major problems which have appeared in reliability research at Sandia Corporation is presented and generalizations based on this experience are discussed. (J.R.D.)

**13064** UCRL-5265

California, Univ., Livermore. Radiation Lab.

VARIATION WITH ELECTRON TEMPERATURE OF THE INTENSITY RATIO OF A PAIR OF HELIUM SPECTRAL LINES. John C. Howard. June 19, 1958. 16p. Contract W-7405-eng-48. OTS.

The dependence on mean electron kinetic energy of the ratio of intensities of  $\lambda 5015(\text{HeI})$  and  $\lambda 6686(\text{HeII})$  has been calculated. A low-density plasma is considered, the principal assumptions being that the reaction processes are governed by electron collisions and the electron energy distribution is Maxwellian. The results show a fairly large variation of the intensity ratio within the range of 3 to 7 ev. (auth)

**13065** UCRL-5713

California, Univ., Livermore. Lawrence Radiation Lab.

A TABLE OF SOME SPHERICAL HARMONICS. D. F. Abell. Nov. 1959. 8p. Contract W-7405-eng-48. OTS.

A table of those spherical harmonics useful in the calculation of energy levels of ions in crystalline electric fields was prepared. Various forms of the harmonics are included. (auth)

**13066** WAPD-BT-17(p.14-18)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

FAST NEUTRON CONVERSION FACTORS AND EFFECTIVE RBE VALUES. K. Shure. 5p.

A review is given of fast neutron conversion factors to be used in instrument calibration and of effective RBE values applicable to instrument readings to obtain biological dose rates from physical dose rates. This review indicates that a conversion factor of 55 neutrons/cm<sup>2</sup>-sec per millirad/hr should be used when calibrating fast neutron instruments with Po-Be sources. Areas are indicated where the neutron spectrum is possibly sufficiently well known to allow the use of RBE values slightly lower than the recommended value of 10. (auth)

**13067** WAPD-BT-17(p.57-64)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

A THREE-DIMENSIONAL FOURIER TRANSFORM SOLUTION OF THE BOLTZMANN EQUATION WITH A LINEARLY ANISOTROPIC SOURCE. R. C. Gast. 8p.

The well known spherical harmonics method is applied to obtain the three-dimensional approximation to the Boltzmann equation in a form suitable for computing moments along a line from an anisotropic point source in an infinite homogeneous medium. A Fourier transform solution is given for the P-1 case with a linearly anisotropic source. A method by which one may obtain approximate expressions for the moments is indicated. (auth)

**13068** WAPD-TM-214

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

TEMP-2—A ONE DIMENSIONAL TRANSIENT THERMAL STRESS PROGRAM FOR THE IBM 704. L. M. Culpepper and D. Jortner. Apr. 1960. 19p. Contract AT-11-1-GEN-14. OTS.

An IBM-704 computer program for the solution of transient thermal stress problems in one dimension is described. For given boundary and initial conditions the transient temperature distribution and stresses are computed. Spherical, cylindrical, and slab geometries can be treated by this program. (auth)

**13069** AEC-tr-4010

INCOMPLETE SEPARATION OF VARIABLES FOR BIVALENT ATOMS. V. A. Fok, M. G. Veselov, and M. I. Petrashev'. Translated by Lydia Venters (Argonne National Lab.) from *Zhur. Eksptl'. i Teoret. Fiz.* **10**, 723-39 (1940). 23p. JCL or LC.

The theory of a computation with incomplete separation of variable for bivalent atoms is given. (W.L.H.)

**13070** AEC-tr-4039

DETERMINATION OF ELECTRODE FORMS IN PIERCE ELECTRON GUNS. R. Hechtel. Translated for Los Alamos Scientific Lab. from *Telefunken Ztg.* **28**, 222-6(1955). 8p. JCL.

A method of calculating the electrode forms for Pierce electron guns used to propagate convergent circular rays is described. Application of the method was made for a gun with a half-aperture angle of 45°. (auth)

**13071** AEC-tr-4042

QUENCHING BY ABSORBING SUBSTANCES AND SENSITIZED FLUORESCENCE IN SOLUTIONS. M. D. Galanin. Translated by Lydia Venters (Argonne National Lab.) from *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **15**, 543-50(1951). 11p. JCL or LC.

Quenching of fluorescence by inductive resonance interaction, i.e., interaction of the excited and unexcited molecules at distances greater than their kinetic radii, is discussed and an equation is derived for the probability of energy transfer in the region of overlapping of the fluorescence and absorption spectra. The probability is proportional to the probability of radiation (fluorescence), to the concentration of the quenching substance, and to the reciprocal of the cube of a radius,  $a$ . This equation holds only for low concentrations. Differences in the changes in yield and mean time of the excited state with increasing concentration are interpreted as being due to instantaneous quenching taking place within a radius,  $b$ . The radii,  $a$  and  $b$ , are shown to be equal. Sensitized fluorescence is also discussed and equations are derived for the fluorescence quenching law, which showed that the duration of the sensitized fluorescence should be larger than that of simple fluorescence (direct excitation). This prediction



was experimentally confirmed, but the extent of the fluorescence due to trivial reabsorption could not be determined. (D.L.C.)

### 13072

#### INVESTIGATION OF THE CHARGING OF CERTAIN NUCLEAR EMULSIONS WITH BORON AND LITHIUM.

V. Laban and M. Nicolae. Acad. rep. populare Romîne, Inst. fiz. atomică și Inst. fiz., Studii cercetări fiz. 9, 231-40(1958). (Translated from Referat. Zhur. Fiz. No. 8, 1959, abstract No. 17211).

A method of charging the plates NIKFI K of 100 microns with boron and lithium was investigated, along with a method of treating the charged plates in order to determine certain neutron fluxes. A curve was plotted for the absorption of boron and lithium per milliliter of emulsion, and the changes of the working characteristics of the emulsion as a function of the concentration were also investigated. Thus, NIKFI K 100 micron plates were obtained, containing 10 to 120 mg of boron/milliliter of emulsion and 3.5 to 20 mg of lithium/milliliter of emulsion, depending on the concentration of the impregnating solution. The plates so charged can serve relative determinations of neutron fluxes. For absolute determinations it is necessary first to calibrate against a standard source.

### 13073

#### A NEW METHOD FOR THE RAPID MEASUREMENT OF THE SHRINKAGE FACTOR OF A NUCLEAR EMULSION.

J. Benicz and O. Borowczak (Highest Pedagogical School, Katowice, Poland). Acta Phys. Polon. 17, 203-5(1958). (Translated from Referat. Zhur. Fiz. No. 8, 1959, abstract No. 17208).

A method is described for measuring the shrinkage factor with the aid of specially constructed pycnometer. The results obtained are in agreement, within the limits of errors, with the data obtained hitherto by other methods.

### 13074

#### THE PARAMETERS ON THE BENEDICT-WEBB-RUBIN EQUATION OF STATE FOR HELIUM-4.

O. V. Lounasmaa (Univ. of Turku, Finland). Ann. Acad. Sci. Fennicae Ser. A VI, No. 38, 1-19(1959). (In English)

Experimental pVT-measurements in the temperature-pressure range 3 to 20°K and 0 to 100 atm were used for determining the eight parameters in the Benedict-Webb-Rubin equation of state for helium-4. The values of parameters are (units: atm, g-mole, liter, °K;  $R = 0.082055$ , Mol. weight of  $\text{He}^4 = 4.0028$ ):  $B_0 = 0.023661$ ,  $A_0 = 0.040962$ ,  $C_0 = -0.16227$ ,  $b = -1.9727 \times 10^{-7}$ ,  $a = -0.00057339$ ,  $\alpha = -7.2673 \times 10^{-6}$ ,  $c = -0.0055210$ ,  $\gamma = 0.00077942$ . The standard deviation in the compressibility factor is 0.029 and in the pressure 0.55 atm, although points up to 3 times the critical density are included. An enthalpy diagram was also computed and the agreement with the experimental values is good until densities twice the critical one. The second and third virial coefficients are in good agreement with earlier values above 5.2°K, the critical temperature of helium-4. (auth)

### 13075

#### ENERGY-RANGE RELATIONSHIP OF THE AGFA-K2 NUCLEAR EMULSION.

D. Bebel (Nuclear Physics Inst., German Academy of Sciences, Berlin). Ann. Physik (7) 5, 144-56(1960). (In German)

On the basis of a method proposed by Vigneron, an energy-range curve for protons in Agfa-K2 emulsions was calculated, and, from experimental energy-range values which were obtained by analysis of thorium decay stars, was calibrated empirically. The calibration is

made by variation of a parameter determined from the mean excitation potential of the emulsion. The calculations cover proton energies from 1 to 70 Mev. Over 10 Mev the range for a given energy is about 10% greater than the corresponding range in Ilford-C2 emulsions. (tr-auth)

### 13076

CALCULATION AND CALIBRATION OF A "CONSTANT-SAGITTA" SCHEME FOR THE AGFA-K2 NUCLEAR EMULSION. D. Bebel (Nuclear Physics Inst., German Academy of Sciences, Berlin). Ann. Physik (7) 5, 157-73(1960). (In German)

On the basis of the Molière theory of Coulomb multiple scattering and an energy-range curve calculated earlier, a "constant-sagitta" cell scheme for the mass determination of traces of singly charged particles of Agfa-K2 emulsions was calculated. Calibration measurements were made on proton tracks with ranges between 5,000 and 12,000 $\mu$ . The theoretical values corrected with respect to inelastic scattering by the atomic electrons lie within simple statistical errors of the experimental results. As a side result, an indication of a possibility for the increase of the resolution of the method is given. (tr-auth)

### 13077

ELECTRON GROUPS IN THE PERIODIC SYSTEM OF THE ELEMENTS IN THE STATISTICAL THEORY OF THE ATOM. T. Tietz (Universität, Łódź, Poland). Ann. Physik (7) 5, 237-40(1960). (In German)

In connection with the work of Theis, an analytical formula for the entire range of Z values is given in which  $\underline{s}$ ,  $\underline{p}$ ,  $\underline{d}$ , and  $\underline{f}$  electrons appear for the first time. The analytical formula yields the atomic number which begins the formation of the  $\underline{s}$ ,  $\underline{p}$ ,  $\underline{d}$ , and  $\underline{f}$  electron groups. The numerical results for the total number of electrons in the atom yield good average values on the empirical values. The total number of electrons is tabulated. (tr-auth)

### 13078

SOME COMMENTS ON WAVE PROPAGATION AND SHOCK WAVE STRUCTURE WITH APPLICATION TO MAGNETO-HYDRODYNAMICS. G. B. Whitham (New York Univ., New York). Communs. Pure and Appl. Math. 12, 113-58(1959) Feb.

An investigation was made of wave propagation and shock wave structure by means of linear and non-linear problems. The conclusions drawn from this study were applied to magnetohydrodynamic problems for conducting fluids in magnetic fields. This investigation was proposed to determine which set of waves in the fluid are the most important and are to be observed and to determine how appropriate boundary conditions should be assigned. (B.O.G.)

### 13079

SUPERCONDUCTIVITY OF METALS CONSIDERING THE OVERLAPPING OF ENERGY BANDS. V. A. Moscalenko (Lomonosov Moscow State Univ.). Fiz. Metal. i Metalloved. 8, 503-13(1959) Oct. (In Russian)

The effects of overlapping energy bands on the superconducting properties of metals were studied by N. N. Bogolyubov's method (JETP 34, 58(1958)). Considerations are given to the effects of lattice vibrations on the transitions of electron pairs from one band to another. Under certain conditions the energy band with higher electron density near the Fermi surface plays the most important part in metal superconductivity. (tr-auth)

### 13080

ON THE POSSIBILITY OF THE INVESTIGATION OF DISTRIBUTION DENSITY OF PHONONS IN A NON-

CUBIC CRYSTAL BY MEANS OF NON-COHERENT SCATTERING OF NEUTRONS. V. S. Oskotskii (Leningrad Inst. of Semiconductors, Academy of Sciences, USSR). *Fiz. Tverdogo Tela* **2**, 701-3(1960) Apr. (In Russian)

Previously G. Placzeka (*Phys. Rev.* **93**, 1207(1954)) postulated that the differential cross section of incoherent inelastic neutron scattering by cubic crystals is proportional to the phonon density  $g(\omega)$ . In the case of non-cubic crystals the cross section depends on phonon polarization, which is unknown. An attempt was made to eliminate phonon polarization from the cross section by investigating composite models. (R.V.J.)

### 13081

ON THE THEORY OF A PLASMA-THERMOELEMENT. B. Ya. Moizhes and G. E. Pikus (Leningrad Inst. of Semiconductors, Academy of Sciences, USSR). *Fiz. Tverdogo Tela* **2**, 756-74(1960) Apr. (In Russian)

Physical processes in the plasma thermoelement were investigated considering local thermodynamic equilibrium and disregarding the generation and recombination in the volume. In the latter case the current was determined by the diffusion of carriers and the load intensity by the contact potential difference. Calculations were made of the volt-ampere characteristics and of efficiency factors for cases in which energy exchange between electrons and atoms is absent and for cases in which the plasma is isothermal. (tr-auth)

### 13082

FLUID DYNAMICS. C. A. Sleicher, Jr. (Univ. of Cambridge, Eng.); R. A. Stern and A. K. Oppenheim (Univ. of California, Berkeley); and L. E. Scriven (Univ. of Minnesota, Minneapolis). *Ind. Eng. Chem.* **52**, 347-58(1960) Apr.

The advent of space flight has emphasized the significance of chemical reactions and their kinetics in aerodynamics and other advanced fields of fluid dynamics. Included is a review of the advances made in recent years in this field. The areas of fluid dynamics reviewed are: flow equations of motion and stability, turbulence, vortex flow and rotation, jets and wakes, flow near solid surfaces, multiphase and free-boundary flow, gas dynamics, gas wave dynamics, dynamics of reactive fluids, and dynamics of conducting fluids. (B.O.G.)

### 13083

OPTICAL ABSORPTION BY FREE CARRIERS IN A SEMICONDUCTOR CONTAINING A DISPERSED COLLOIDAL PHASE. B. R. Gossick (Arizona State Univ., Tempe). *J. Appl. Phys.* **31**, 648-9(1960) Apr.

The optical absorption by free carriers in a semiconductor containing a dispersed colloidal phase is treated, taking into account the dipolar diffusion of minority carriers about the particles. (auth)

### 13084

FORMATION AND INITIAL GROWTH OF SINGLE-ASPERITY SOLID-STATE BONDS. F. C. Holden, J. B. Melehan, H. R. Ogden, and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). *J. Appl. Phys.* **31**, 670-3(1960) Apr.

A gold needle point in contact with a gold flat was used to study the formation and initial growth of single-asperity solid-state bonds. In the absence of external pressure, the growth of the bonded area can be expressed analytically by a diffusion-controlled rate equation. Values for the coefficient of self-diffusion determined from these experiments are in reasonable agreement with those given in the recent literature. (auth)

### 13085

ON THE YIELD AND ENERGY DISTRIBUTION OF SECONDARY POSITIVE IONS FROM METAL SURFACES. Henry E. Stanton (Argonne National Lab., Lemont, Ill.). *J. Appl. Phys.* **31**, 678-83(1960) Apr.

The kinetic energy distribution of secondary positive ions liberated from a solid metallic target of beryllium under bombardment by positive ions was measured in a mass spectrometer provided with an energy analyzer. In conformity with earlier investigations, it was found that an appreciable fraction of the ions was liberated with energies less than 5-10 ev, although some secondary ions of more than 200 ev were found. The distributions appeared to be at least partially Maxwellian in character. Although errors in measurement were large, there appeared to be little dependence of the yield of secondary ions on the mass of the bombarding ion. (auth)

### 13086

ANALYSIS OF COMPOSITE X-RAY DIFFRACTION PROFILES. J. J. Slade, Jr., and J. F. Nanni (Rutgers Univ., New Brunswick, N. J.). *J. Appl. Phys.* **31**, 699-706(1960) Apr.

The irregular line profiles associated with crystals that have a random structure which is coarse relative to the irradiated area are regarded as the result of the composition of a characteristic distribution and a set of broadening and translating processes. The inversion of this composition is expressed operationally. A differential operator associated with the transform of the intrinsic distribution is introduced. This operator reduces the line profile to the set of broadening and translating elements. The operations are such as may be performed by an analogue computer. Preliminary experiments show that it may be possible to obtain the desired resolution. The effects of "noise" and distortion are investigated. (auth)

### 13087

METHOD FOR DETERMINING THE THERMAL CONDUCTIVITY OF INCANDESCENT SOLIDS. B. B. Brenden and H. W. Newkirk (General Electric Co., Richland, Wash.). *J. Appl. Phys.* **31**, 737-8(1960) Apr.

A method is given for determining the thermal conductivity of incandescent solids above 1000°C. A formula is given for this calculation using bottom, middle, and top surface true temperatures and the total emissivity. Comparisons are made of values for graphite and uranium dioxide with other studies. Refinements in the technique promise greater accuracy than realized in these preliminary experiments. (B.O.G.)

### 13088

MONTE CARLO CALCULATIONS OF THE MOTIONS OF ELECTRONS IN HELIUM. T. Itoh and T. Musha (Electrical Communication Lab., Tokyo). *J. Appl. Phys.* **31**, 744-5(1960) Apr.

Monte Carlo calculations are described for the ionization and excitation coefficients of electrons in uniform electric fields. These formulas were good approximations to the experimental results up to electron energies of 200 ev. This process enabled tracing the motion of one electron throughout the calculations. These calculations were made in the case of He for  $E/P = 40, 80$ , and  $160$  v/cm/mm Hg, where  $E$  is the strength of the electric field and  $P$  is the gas pressure at constant temperature. (B.O.G.)

### 13089

TRANSISTOR WITH BASE CONTAINING A DISPERSED COLLOIDAL PHASE. B. R. Gossick (Arizona State Univ., Tempe). *J. Appl. Phys.* **31**, 745(1960) Apr.



A proposal is presented for the fabrication of transistors with an *n*-type base containing *p*-type particles (or a *p*-type base with colloidal *n*-type particles) in the anticipation of extending the gain-bandwidth product. If this were followed, the optical extinction by the colloidal phase might be effectively employed in techniques of development and production. (B.O.G.)

### 13090

ANALYSIS OF THE SOLID-STATE SPECTRA OF TRIVALENT NEODYMIUM AND ERBIUM. B. G. Wybourne (Univ. of Canterbury, Christchurch, N. Z.). *J. Chem. Phys.* **32**, 639-42(1960) Mar.

A term analysis of the solid-state spectra of trivalent neodymium and erbium was made and terms were assigned to most of the observed levels of these ions. The complete spin-orbit matrices corresponding to the  $f^3$  and  $f^{11}$  configurations were diagonalized to calculate the energy level schemes for the neodymium and erbium ions, respectively. The electrostatic interaction energies are included and the appropriate parameters were calculated by a least-squares method. (auth)

### 13091

DETONATION PRESSURE OF LIQUID TNT. W. B. Garn (Los Alamos Scientific Lab., N. Mex.). *J. Chem. Phys.* **32**, 653-5(1960) Mar.

The plane steady-state detonation pressure behind the reaction zone of liquid TNT is reported. This pressure of 171.8 kilobars was established by measuring free-surface velocity as a function of plate thickness for 2024 aluminum plates placed in contact with the detonating explosive. The zero thickness metal shock pressure, obtained by extrapolating the free-surface velocity data, was corrected to the corresponding detonation pressure by an impedance matching calculation. Recording was done by a sweeping-image camera technique. (auth)

### 13092

LOW EXCITED STATES IN  $C_2$ . Enrico Clementi and Kenneth S. Pitzer (Univ. of California, Berkeley). *J. Chem. Phys.* **32**, 656-62(1960) Mar.

The energies of the low electronic states of the  $C_2$  molecule were calculated, using a semiempirical approach. In the calculation, the two-center core integrals, and the one-center Coulomb integral, are empirical parameters which were obtained by fitting of the Morse potential curves and from atomic data, respectively. The standard ASMO—LCAO state wave functions were expanded in covalent, single ionic, and double ionic components, which are constructed so as to obey the Wigner-Wittmer dissociation rules at infinite internuclear distances. The contributions for each component of the expanded state wave functions were obtained by the variational method. The states considered were the  $^1\Sigma_g^+$  state of the  $\pi_u(4)$  configuration (of 2p orbitals), the  $^1\Pi_u$  and  $^1\Pi_g$  states of the  $\pi_u(3)\sigma_g(1)$  configuration, and the  $^3\Sigma_g^+$ ,  $^1\Delta_g$ ,  $^1\Sigma_g^+$  states of the  $\pi_u(2)\sigma_g(2)$  configuration. The calculated energies of the  $^1\Sigma_g^+$  and  $^1\Pi_u$  electronic states agreed well with experiment. A critical analysis is given of the coefficients of the expansion in covalent and ionic structures. (auth)

### 13093

THE MECHANISM AND EFFICIENCY OF ELECTROLUMINESCENCE IN ZnS PHOSPHORS. F. F. Morehead, Jr. (General Electric Co., Cleveland). *J. Electrochem. Soc.* **107**, 281-7(1960) Apr.

A model of the electroluminescent process is applied to the photon emission and power consumption of insulated electroluminescent phosphors as a function of voltage and

frequency. The model leads to a convenient summary of such data and an increased understanding of their significance. An upper limit to the efficiency of impact electroluminescence in insulated particles is proposed on the basis of the model. (auth)

### 13094

THE EFFECT OF METEOROLOGICAL VARIABLES UPON THE VERTICAL AND TEMPORAL DISTRIBUTIONS OF ATMOSPHERIC RADON. Harry Moses, Andrew F. Stehney, and Henry F. Lucas, Jr. (Argonne National Lab., Lemont, Ill.). *J. Geophys. Research* **65**, 1223-38(1960) Apr.

Hourly values of radon concentrations were obtained simultaneously at four levels above ground up to 39.9 meters on the Argonne Meteorology Tower on three separate days. Twenty-seven consecutive hourly measurements were made on the first two days, and 17 on the third. Radon samples were obtained by adsorption on activated charcoal and were measured by means of scintillation counters. This technique, developed at Argonne, allowed direct measurement of radon instead of the common procedure of calculating radon values from measurements of daughter products. The large amount of meteorological data routinely obtained at the Argonne Meteorology Laboratory makes it possible to carry out detailed case studies on the relationship between radon concentration and the meteorological variables. This work has provided information on the heterogeneity of the horizontal distribution of radon. An inverse fumigation phenomenon was observed. Under very stable nighttime conditions with light winds the radon concentrations observed at the top of the tower remained very low—about the same as during the daytime. Shortly after sunrise, with an increase in vertical mixing, the concentrations rose sharply. At a height of about 5.72 meters the radon concentrations on the clear nights were larger by a factor of 20 than concentrations on the clear days. During cloudy conditions nighttime values were about twice as large as daytime values. (auth)

### 13095

GENERALIZED ORBITAL ANGULAR MOMENTUM AND THE *n*-FOLD DEGENERATE QUANTUM-MECHANICAL OSCILLATOR. PART I. THE TWOFOLD DEGENERATE OSCILLATOR. James D. Louck and Wave H. Shaffer (Ohio State Univ., Columbus). *J. Mol. Spectroscopy* **4**, 285-97(1960) Apr.

An operational procedure is used to determine the eigenvalues and eigenfunctions for the quantum-mechanical twofold degenerate oscillator problem in polar coordinates. The procedure leads automatically to the determination of the nonvanishing matrix elements of the cartesian coordinates and conjugate linear momenta of the oscillator. (auth)

### 13096

GENERALIZED ORBITAL ANGULAR MOMENTUM AND THE *n*-FOLD DEGENERATE QUANTUM-MECHANICAL OSCILLATOR. PART II. THE *n*-FOLD DEGENERATE OSCILLATOR. James D. Louck (Los Alamos Scientific Lab., N. Mex.). *J. Mol. Spectroscopy* **4**, 298-333(1960) Apr.

A set of commuting generalized orbital angular momentum operators in *n*-dimensional polar coordinates is defined and their eigenvalues and simultaneous eigenfunctions determined by the use of results from the factorization method of solving eigenvalue problems. A set of generalized orbital angular momentum components is

also defined and relations are given for determining their nonvanishing matrix elements. The  $n$ -fold degenerate oscillator radial equation is solved by a quadruple factorization of the hamiltonian and these radial equation results are combined with the generalized angular momentum results to obtain relations from which the nonvanishing matrix elements of the cartesian coordinates and conjugate linear momenta of the oscillator can be calculated. (auth)

### 13097

#### GENERALIZED ORBITAL ANGULAR MOMENTUM AND THE $n$ -FOLD DEGENERATE QUANTUM-MECHANICAL OSCILLATOR. PART III. RADIAL INTEGRALS.

James D. Louck (Los Alamos Scientific Lab., N. Mex.). *J. Mol. Spectroscopy* **4**, 334-41(1960) Apr.

The hydrogen-atom radial equation is solved by transforming it to a twofold degenerate oscillator radial equation, and the explicit relation between the hydrogen-atom and oscillator radial functions is written out. This relation can be used to evaluate various two-dimensional oscillator radial integrals from known hydrogen-atom radial integrals or vice versa. Also, an identity is derived between two types of radial integrals involving the hydrogen-atom radial functions or the  $n$ -fold degenerate oscillator radial functions. (auth)

### 13078

CHARACTERISTICS OF THE NUCLEAR EMULSIONS He-4 AND He-5. Han-tcheng Sun, Hwei-chang Lou, and Zah-wei Ho. *K'o Hsüeh T'ung Pao* No. 5, 151-3(1958). (Translated from *Referat. Zhur. Khim.* No. 9, 1959, abstract No. 32699).

The properties of the nuclear plates, He-4 and He-5, in comparison with similar properties of photographic plates, are described for the purposes of nuclear physics, Ilford G-5, and NIKFI R.

### 13099

USE OF PLASTIC PHOSPHORS FOR MEASUREMENT OF NEUTRON ENERGY. Andras Neszmelyi and Gabriella Palla. *Magyar Tudományos Akad. Közponi Fiz. Kutató Intézetének Közleményei* **6**, 138-46(1958). (Translated from *Referat. Zhur. Fiz.* No. 8, 1959, abstract No. 17139).

For various plastic phosphors, the dependence of the pulse amplitude on the electron energy and on the  $\alpha$ -particle energy was measured. The measured values for one of the scintillators range from  $12.4$  to  $15.4 \times 10^{-3}$  g/Mev-cm. Graphs are given for the energy measurements with organic scintillators.

### 13100

RADIOACTIVE SELF-LUMINOUS COMPOUNDS. I. LUMINOUS COMPOUNDS. Ryōichiro Fujimura and Yasuro Atō. *Nagōya Kogyō Gijutsu Shikensho Kōkoku* **8**, 521-6 (1959) July. (In Japanese)

Self-luminous compounds were prepared by activating them with  $\beta$  sources. A salt containing a radioisotope such as  $P^{32}$ ,  $S^{35}$ , or  $Se^{80}$ - $Y^{80}$  was mixed with an inorganic phosphor, and the relative efficiency of the conversion of  $\beta$  ray energy into light quanta, i.e., the ratio of the emitted light intensity to the  $\beta$  counting rate of the sample was determined. A ZnS-type phosphor with a long afterglow was the most efficient, but the level of brightness was as low as the order of  $1 \mu$  L/mc. The effects of the carrier concentration up to 5% and the specific radioactivity on the efficiency were not excessive. Experimental data are graphed. (OID)

### 13101

ISOTOPIC COMPOSITION OF POTASSIUM. B. R. F.

Kendall (Univ. of Western Australia, Nedlands). *Nature* **186**, 225-6(1960) Apr. 16.

Results are reported from a survey of the isotopic composition of potassium in samples of mineral and biological origin, and in sea water. Repeated analyses were made of the potassium-39/potassium-41 ratio in 27 samples and the potassium-41/potassium-40 ratio in 15 samples. Extensive tests were carried out to eliminate sources of experimental error and to establish accurately the probable errors due to the remaining random effects. Results are discussed. (C.H.)

### 13102

#### THEORY OF ELECTRICAL CONDUCTION IN HIGH

MAGNETIC FIELDS. P. N. Argyres and L. M. Roth (Massachusetts Inst. of Tech., Lexington, Mass.). *Phys. and Chem. Solids* **12**, 89-96(1959) Dec.

Present quantum-mechanical theories of transport in high magnetic fields are shown to be deficient in that they neglect the effect of the electric field on scattering. It is demonstrated that in the case of large Hall angles, i.e.  $\omega_0 \tau \gg 1$ , the transverse current can be obtained by a direct expansion in powers of the scattering potential. The transverse current can be described in terms of the drift of the centers of cyclotron orbits of the electrons in the magnetic field. This justifies the original semiclassical method of calculation, but such a procedure is correct only for a non-oscillating electric field. (auth)

### 13103

#### VAPOR PRESSURE OF $He^3$ - $He^4$ SOLUTIONS. A. K.

Sreedhar and J. G. Daunt (Ohio State Univ., Columbus). *Phys. Rev.* **117**, 891-6(1960) Feb. 15.

Measurements were made on the vapor pressures of solutions of  $He^3$  in  $He^4$  having molar  $He^3$  concentrations 1.91, 3.34, 6.51, and 12.04% in the temperature range 1.4 to 2.6°K. The results are compared with previous evaluations and comparisons made with recent theories of  $He^3$ - $He^4$  solutions. (auth)

### 13104

#### EXCHANGE AND CORRELATION EFFECTS IN ELECTRON-PHONON SCATTERING IN NORMAL

METALS. M. Bailyn (Northwestern Univ., Evanston, Ill.). *Phys. Rev.* **117**, 974-84(1960) Feb. 15.

The theory of Bardeen for the electron shielding of the perturbation potential arising from lattice vibrations is extended to cover exchange and correlation effects. The method is to set up a self-consistent set of one-electron equations, and calculate the effect of the perturbation in the charge densities. The exchange term is corrected to conform to the results of the Bohm-Pines theory, but the plasma wave function is assumed not to be disturbed by the lattice. With this approximate model, a solution to the problem can be obtained. For small-angle scattering, the results do not return to the original Bardeen values. The interaction potential matrix element depends on the initial electron wave vector  $k$  as well as on the difference between initial and final state wave vectors. Hence, to use the results an average over  $k$  must be made, and an average was made over the Fermi surface. The general effect of the exchange hole is to increase the scattering. (auth)

### 13105

LEAD K ABSORPTION EDGE FOR  $\mu$ -MESON MASS DETERMINATION. Alan J. Bearden (Johns Hopkins Univ., Baltimore). *Phys. Rev. Letters* **4**, 240-1(1960) Mar. 1.

Using a two-crystal spectrometer with the diffracted x-ray beam passing through the crystals, a measurement of the lead K absorption edge was made. The mass-



attenuation coefficient of lead was measured at 88,450 ev and found to be  $7.30 \pm 0.1 \text{ cm}^2/\text{g}$ . (C.J.G.)

### 13106

DEVELOPMENT OF A COMPACT EVACUATED PULSED NEUTRON SOURCE. J. D. Gow (Univ. of California, Berkeley) and H. C. Pollock (General Electric Research Lab., Schenectady, N. Y.). *Rev. Sci. Instr.* **31**, 235-40 (1960) Mar.

A pulsed neutron source was developed whose principal element is a sealed-off vacuum tube in which a discharge between titanium tritide surfaces produces tritons, which then are accelerated to a deuterium-loaded target. The construction of a tube producing approximately  $10^7$  neutrons in microsecond pulses and having a life of several thousand pulses is described. (auth)

### 13107

THE SCINTILLATION LIGHT YIELD OF ANTHRACENE FOR POSITRONS AND ELECTRONS OF LOW ENERGY. K. Gubernator, P. H. Heckmann, and A. Flammersfeld (Universität, Göttingen, Ger.). *Z. Physik* **158**, 268-73 (1960). (In German)

The scintillation response of anthracene crystals to positrons and electrons is investigated in the energy region below 200 kev and is found to be linear within experimental error, with an intercept on the energy axis of a few kev, depending on size and surface conditions of the crystal. The light yield of positrons might be slightly below that of electrons, but the difference is less than about 2%. (auth)

### 13108

MICROPROJECTION WITH X-RAYS. Ong Sing Poen. Thesis, Delft, Netherlands, Technische Hogeschool, 1959. 132p. (In English)

The properties and limitations of the projection x-ray microscope are discussed. Descriptions of five types of x-ray microscopes are given. A focusing method which works independently of the x rays is described. This has been realized by using electrons which are elastically reflected at the target; they pass the lens in the opposite direction and give an enlarged image of the focus at the electron source. The properties of film materials to be used in x-ray photography are discussed and a definition of the film quality, applied to projection microscopy, is proposed. The contrast improvement obtained by the use of ultra fine grain film is discussed. Practical applications of x-ray microscopy are discussed. The conditions for making good stereoscopic exposures are described and the necessity for a calibrated object shift is described. (C.J.G.)

### 13109

QUANTUM ELECTRONICS. A SYMPOSIUM. Charles H. Townes, ed. New York, Columbia University Press, 1960. 618p. \$15.00

Papers and discussions from the Conference on Quantum Electronics—Resonance Phenomena held at High View, New York, on Sept. 14-16, 1959, are given. Recent developments in masers, atomic clocks, paramagnetic resonance, optical pumping, parametric amplifiers, the application of very sensitive amplifiers to radioastronomy, and quantum effects in amplifiers and communication are covered to give a comprehensive view of current research. General papers on the principal topics of the conference are in most cases followed by related specialized papers. (W.D.M.,

TARY ATMOSPHERE. Astronautics Information Literature Search No. 196. Judy Hayes. Mar. 15, 1960. 19p. Contract NASw-6.

A bibliography, containing 97 references from work published between 1956 to 1959, is presented on methods for investigating lunar, planetary, and the earth's atmospheres. (C.J.G.)

## Cosmic Radiation

### 13111 INS-TCA-13

[Tokyo Univ.]. Inst. for Nuclear Study.

I. N. S. AIR SHOWER REPORT. T. Matano, I. Miura, M. Oda, K. Suga, G. Tanahashi, and Y. Tanaka. Oct. 14, 1958. 21p.

The results of a study of extensive air showers during a period in July 1958 are presented. The total number of particles of the shower and the location of its axis were determined for each shower with the aid of seven scintillation detectors. The incident direction, size spectrum, zenith angle distribution, and lateral distribution of particle densities were determined. (W.D.M.)

### 13112

CORPUSCULAR RADIATION EXPERIMENT OF SATELLITE 1959 IOTA (EXPLORER VII). George H. Ludwig and William A. Whelpley (State Univ. of Iowa, Iowa City). *J. Geophys. Research* **65**, 1119-24(1960) Apr.

Satellite 1959t (Explorer VII) carries an apparatus prepared by the Department of Physics and Astronomy of the State University of Iowa for comprehensive spatial and temporal monitoring of total cosmic-ray intensity, geomagnetically trapped corpuscular radiation, and solar protons. In view of the successful operation of the equipment during the first 2 months of flight and the expectation of its continued operation until October 1960, it was considered desirable and worth while to invite international participation in the recording and interpretation of the radiation observations. A full description of the apparatus is given, including detector calibrations, telemetry code, samples of actual recordings, and other pertinent information. (auth)

### 13113

ON THE THEORY OF PROTONS TRAPPED IN THE EARTH'S MAGNETIC FIELD. Ernest C. Ray (State Univ. of Iowa, Iowa City). *J. Geophys. Research* **65**, 1125-34 (1960) Apr.

A differential equation of transport is written for protons losing energy in an atmosphere but not scattering. It is solved under the approximation that a proton loses a negligible amount of energy while it drifts once around the earth in longitude. Three cases are treated: the equilibrium solution with input and loss rates equal; the solution for impulsive injection at  $t = 0$ , the intensity then dying away; and the solution for the intensity zero initially, the input mechanism being turned on at  $t = 0$ . No numerical work bearing on the geometry of the source function is included. The treatment is an improvement over previous ones in that it adequately treats the particles as moving along their actual trajectories. A detailed comparison with observations over South Africa shows that the altitude dependence of intensity is roughly consistent with the view that the particles seen by the unshielded Geiger tube on 1958e are protons supplied by a weak source (for example, by decay of albedo neutrons) which are lost to the detector when their energy is reduced below the detection threshold by absorption. The atmosphere required has a temperature of about 2000°K at 400 km if it is pure dissociated nitrogen.

## Astrophysics and Cosmology

### 13110 JPLAI-LS-196

California Inst. of Tech., Pasadena. Jet Propulsion Lab. INVESTIGATING THE LUNAR ATMOSPHERE AND PLANE-

At some height between about 1100 and 1300 km the scale height sharply increases in a way consistent with the view that at this height the composition changes to pure dissociated hydrogen. Only relative intensities are used in these comparisons. (auth)

### 13114

RADIATION INFORMATION FROM 1958<sub>2</sub>. R. P. Basler, R. N. DeWitt, and G. C. Reid (Univ. of Alaska, College). *J. Geophys. Research* **65**, 1135-8(1960) Apr.

The telemetered radiation information from the satellite 1958<sub>2</sub> (Sputnik III) was analyzed for 62 separate passes recorded in College, Alaska. The data indicate a dependence of radiation intensity on altitude in the range 250 to 500 km. Both the high- and the low-energy components apparently contribute to the over-all increase of intensity with altitude, but the presence of a continuous afterglow in the scintillating crystal prevented detailed interpretation of the results. (auth)

### 13115

THE DETERMINATION OF IONOSPHERIC ELECTRON CONTENT AND DISTRIBUTION FROM SATELLITE OBSERVATIONS. PART 1. THEORY OF THE ANALYSIS. Owen K. Garriott (Stanford Univ., Calif.). *J. Geophys. Research* **65**, 1139-50(1960) Apr.

Two techniques are described which permit the integral of the electron density up to the satellite height to be deduced from the satellite radio transmissions. One method is based on the rate of polarization rotation due to the Faraday effect. The other method depends on a measurement of the total angle of polarization rotation at the time of closest approach of the satellite. If useful results are to be obtained, a number of corrections to assumptions made in the simplified analysis are necessary to account for path splitting between the two magneto-ionic components, error in the 'high-frequency approximation,' refraction, and satellite-antenna motion. Owing to the slow rotation of the satellite perigee position, the height of the passage at any given latitude varies. Variations of the integrated electron density with height can then be related to the electron-density profile. (auth)

### 13116

THE DETERMINATION OF IONOSPHERIC ELECTRON CONTENT AND DISTRIBUTION FROM SATELLITE OBSERVATIONS. PART 2. RESULTS OF THE ANALYSIS. Owen K. Garriott (Stanford Univ., Calif.). *J. Geophys. Research* **65**, 1151-7(1960) Apr.

The results of observations of the radio transmissions from Sputnik III (1958<sub>2</sub>) in an 8-month period are presented. The measurements of integrated electron density are made in two ways, described in part 1. The measurements reveal the diurnal variation of the total ionospheric electron content; and the ratio of the total content to the content of the lower ionosphere below the height of maximum density in the F layer is obtained. An estimate of the average electron-density profile above the F-layer peak is made possible by the slow variation in the height of the satellite due to rotation of the perigee position. The gross effects of large magnetic storms on the electron content and distribution are found. (auth)

### 13117

VERTICAL TRANSPORT OF ELECTRONS IN THE F REGION OF THE IONOSPHERE. Sushil Chandra, J. J. Gibbons, and E. R. Schmerling (Pennsylvania State Univ., University Park). *J. Geophys. Research* **65**, 1159-75(1960) Apr.

From the equation of continuity for free electrons, an

expression is developed for the vertical transport velocity which can be evaluated, subject to some limitations, from electron-density-height profiles. A few numerical computations of the vertical drift velocities determined for the four IGY stations Huancayo and Talara, Peru; Panama, Canal Zone; and Washington, D. C., are presented. It is shown that the velocity is predominantly downward during the night and upward during the day at the equatorial stations. There is an apparent phase reversal from summer to winter at Washington. The order of magnitude of the vertical-velocity amplitude is 25 m/sec. There is substantial agreement between the values calculated here from ionospheric data and those deduced from  $S_q$  data on the dynamo theory. (auth)

### 13118

IONOSPHERIC ABSORPTION INVESTIGATIONS AT HAWAII AND JOHNSTON ISLAND. A. Fredriksen and R. B. Dyce (Stanford Research Inst., Menlo Park, Calif.). *J. Geophys. Research* **65**, 1177-81(1960) Apr.

Measurements of ionospheric absorption by the cosmic-noise monitoring method show that, at certain tropical latitudes, an irregular component of absorption is often present in the evening hours. If the variable absorption is present at one observing site (Johnston Island), then variations are also likely to be present at another station about 1325 km away (Hawaii). The individual variations of absorption as a function of time are not correlated at the two stations, suggesting that the scale of the patches causing the absorption must be less than about 1000 km. An attempt is made to find a correspondence between hourly averages of the apparent absorption with other ionospheric parameters. Both a nighttime and daytime absorption are observed. A greater nighttime component appears at Johnston Island than at Hawaii, implying the existence of a latitude dependence. Correlation with spread F or with sporadic E on the basis of ionosonde data from Maui was not found, although a correlation is apparent between cosmic-noise absorption and ionosonde minimum reflection frequency during geomagnetically quiet periods. There is good correlation between average hourly values of the absorption and  $F_2$  critical frequency  $f_oF_2$ . This latter observation is explainable by the shielding effect of the F region. (auth)

### 13119

EXAMINATION OF AN ARRANGEMENT FOR MEASURING THE NUCLEON COMPONENTS OF COSMIC RAYS. W. Lotz, A. Sittkus, and W. Hassler (Universität, Freiburg i. B.). *Nuclear Instr. and Methods* **6**, 296-300(1960) Mar. (In German)

A description is given of the Neutron Intensity Monitor on the Schauinsland near Freiburg im Breisgau, Germany. By adding 60 boron-10-detectors to the Standard-Pile-Geometry designed by Simpson et al. it was possible to reduce the statistical error from 0.46 to 0.29% for the hourly mean. The barometric pressure coefficient was  $0.755 \pm 0.010\%$  mbar<sup>-1</sup> in 1957 and  $0.73 \pm 0.02\%$  in 1958. The median rigidity of the primaries is estimated to be 18 bv. A method is suggested by which it should be possible to shift the median to lower rigidities. (auth)

### 13120

TEMPORARY CAPTURE OF COSMIC RAY PARTICLES AND THEIR CONTRIBUTION TO THE HIGH INTENSITY BELTS. R. Gall (Universidad, Mexico City and Instituto Nacional de la Investigación Científica, Mexico City) and J. Lifshitz (Instituto Nacional de la Investigación Científica, Mexico City). *Nuovo cimento* (10) **15**, 233-45(1960) Jan. 16. (In English)



The theory of the temporary permanence of charged particles in the vicinity of unstable principal periodic orbits in the earth's magnetic field is discussed in relation to the high intensity belts surrounding the earth. The intervals of energies of protons temporarily trapped by this mechanism are calculated for various latitudes and distances. Several possible sources of charged particles and their contribution to the high intensity belts are discussed. The intensity due to the temporary capture of primary cosmic ray protons is calculated. The theoretical intensity curves are compared with the experimental curves taken aboard Pioneer III. The secondary albedo protons spectrum is deduced. Theoretical isotensity curves for captured primary and secondary protons are plotted for the distances from 2 to 8 earth's radii. (auth)

13121

SOLAR FLARE CONNECTED WITH AN INCREASE OF INTENSITY OF COSMIC RAYS. L. Krivský (Astronomical Inst., Czechoslovak Academy of Sciences, Ondřejov); J. Hladký and P. Mokř (Physical Inst., Czechoslovak Academy of Sciences, Prague); P. Chaloupka (Lab. of Physics, Slovak Academy of Sciences, Bratislava); and T. Kowalski (Inst. for Geophysics, Polish Academy of Sciences, Warsaw). *Nuovo cimento* (10) 15, 695-6(1960) Feb. 16. (In English)

A chromospheric flare of importance 1+ was recorded near Prague, Czechoslovakia, on October 6, 1959. An increase of cosmic-ray intensity was recorded during that period, occurring in the diffuse impact zone. (C.J.G.)

13122

LATITUDE EFFECT ON EXTENSIVE AIR SHOWERS OF COSMIC RAYS. Seinosuke Ozaki (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* 117, 1125-7(1960) Feb. 15.

The variation of air shower counting rate with latitude was measured between 7 and 50°N at sea level. The observed showers have  $10^6$  charged particles on the average. No latitude effect on the intensity was found. (auth)

13123

FLUX AT SEA LEVEL OF HEAVY CHARGED PARTICLES PAIR-PRODUCED IN COSMIC RAY SHOWERS. A. Goldberg (Stanford Univ., Calif.). *Phys. Rev.* 117, 1128-9(1960) Feb. 15.

The flux at sea level of charged particles with mass 300 to 600 electron masses is calculated assuming the particles to be pair-produced by cosmic ray photons. The cross section for pair production, including the effects of nuclear size, is folded into the distribution of photons predicted by shower theory. Absorption of the produced particles is also considered approximately. The results are well below the experimental upper limit set up by Keuffel and co-workers. (auth)

13124

SOME PROPERTIES OF THE VAN ALLEN RADIATION. A. J. Dessler and Robert Karplus (Lockheed Aircraft Corp., Missiles and Space Div., Palo Alto, Calif.). *Phys. Rev. Letters* 4, 271-4(1960) Mar. 15.

The results of the observations of the outer zone (the electron belt) of the Van Allen radiation belt made with Explorer IV and Explorer VI satellites are shown to be inconsistent with the solar injection hypothesis. It is shown that the electrons released in the decay of cosmic neutron albedo may represent a satisfactory source for the outer zone. (C.J.G.)

13125

MEASUREMENT OF THE PULSE SPECTRUM AND POSI-

TIVE EXCESS OF COSMIC PARTICLES AT SEA LEVEL. O. C. Allkofer (Universität, Kiel). *Z. Physik* 158, 274-83 (1960). (In German)

With a cosmic radiation pulse spectrograph, in which the local recording of the charged cosmic radiation was made with parallel-plate spark counters and the deflection with a permanent magnet with a deflecting power of  $4000 \times 20$  gauss-cm, the pulse spectrum of cosmic  $\mu$  mesons in a pulse range from  $2 \times 10^9$  to  $6 \times 10^{10}$  ev/c was measured at sea level. The results agree in essence with previous measurements. Three measurements of the intensity ratio of positive to negative mesons (positive excess) were also made. (tr-auth)

## Criticality Studies

13126 HW-24454

Hanford Works, Richland, Wash.

PROPOSED METHOD FOR TREATING HYDROGEN DISPLACEMENT EFFECTS IN CRITICAL MASS MEASUREMENTS. Paul F. Gast. May 13, 1952. Decl. Feb. 24, 1960. 12p. OTS.

Analysis of data on the critical masses of Pu solutions revealed that significant increases in the critical mass occur when the H density is reduced by dilution with heavier nuclei. Recommendations for study of this problem are outlined. Calculations for various situations are included. (B.J.R.)

13127 IDO-16201

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

EFFECT OF NEUTRON INTERACTION ON CRITICAL SIZE. J. W. Webster. Nov. 5, 1954. Decl. Mar. 2, 1960. 20p. Contract AT(10-1)-205. OTS.

It has recently been proposed to increase the diameter and length of the ICPP product shipping containers. The new diameter will be about 6.08 inches O.D. This decrease, in the diameter difference between the bottle diameter and the diameter at which it is believed the solution would be critical, has made the question of neutron interaction between the containers in storage and transit a more sensitive one. A method is derived for calculating critical size with interaction and the method is applied to various possible arrays. It is concluded that all the arrays studied are safe except for one. In this one the containers are assumed to be in two rows, two bottles high, 8 feet apart, and with a 2 foot center-to-center spacing in a row. Two bottles (one on top of the other) are then moved between the rows. The margin between the calculated critical diameter for this case and the bottle design diameter was not considered adequate in the light of uncertainties in the method and other imponderables. (auth)

13128 Y-853

Carbide and Carbon Chemicals Co. Y-12 Plant, Oak Ridge, Tenn.

APPLICATION OF CRITICALITY INFORMATION TO Y-12 PLANT PROBLEMS. C. L. Schuske. Mar. 11, 1952. Decl. Mar. 2, 1960. 37p. Contract W-7405-eng-26. OTS.

The methods developed at Y-12 for the analysis of specific criticality problems are presented. The accumulated results of previous analyses of empirical data permit criticality evaluation of situations for which no experimental data are available. The bulk of the information is presented graphically; the use of each graph being demonstrated by one or more numerical examples. Where more than one method is available for treating a particular

problem, all alternative methods have been rejected in favor of the one which relies most heavily on the experimental data. (C.H.)

### 13129

#### SUBCRITICAL REACTOR AS A COLLEGE FACILITY.

Frank S. Dietrich (Haverford Coll., Penna.). *Am. J. Phys.* **28**, 309-14(1960) Apr.

A subcritical assembly of natural uranium and ordinary water was constructed at Haverford College as an educational instrument. Many of its parameters were determined; their theoretical calculation and experimental measurement are discussed. (auth)

## Elementary Particles

### 13130 AFOSR-TN-60-303

Maryland. Univ., College Park.

#### FINAL STATE INTERACTIONS AND $|\Delta I| = \frac{1}{2}$ RULE.

Physics Department Technical Report No. 168. K. Chadan and S. Oneda. Mar. 1960. 6p. Contract AF49(638)-24.

The final state interactions of strange particle decays were investigated relative to the  $|\Delta I| = \frac{1}{2}$  rule. The validity of this rule was investigated relative to the three interpretations: (1) no rule and a strong attractive pion-pion interaction in  $I = 0$ ,  $J = 0$  state; (2) strict rule and a strong attractive pion-pion interaction in  $I = 2$ ,  $J = 0$  state; and (3) the usual rule, i.e., the structure of primary weak interactions is such that the rule holds and the final state interaction does not play an essential role as in case (1) or (2). (C.J.G.)

### 13131 FZM-1128

Convair, Fort Worth, Tex.

#### THE SCATTERING OF NEUTRONS AND GAMMA RAYS

IN AIR AND GROUND. M. B. Wells. Aug. 1, 1958. 16p.

A Monte Carlo solution to the problem of determining scattered dose rates from neutrons and gamma rays which have been affected by collisions in air and ground is presented. Comparisons of Monte Carlo results with radiation measurements indicate that this method can be used to predict observed dose rates for air and ground scattering within the statistical accuracy of the calculations. (J.R.D.)

### 13132 IDO-16592

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

#### SCATTERING OF NEUTRONS BY GASEOUS MOLECULES.

H. L. McMurray. Mar. 22, 1960. 57p. Contract AT(10-1)-205. OTS.

The problem of calculating the energy distribution of reactor neutrons in the "thermal" region where neutrons can gain as well as lose energy on collisions is considered. Often this spectrum is assumed to be a Maxwellian distribution, or a "hardened" Maxwellian resulting from preferential capture of the lower energy neutrons. This implies that the energy states of the material with which the neutrons collide can be described by a Maxwell distribution, and that the neutrons "live" long enough so their energy distribution comes into equilibrium. For many moderators these assumptions are questionable. As an initial approach to the problem of finding how the energy distribution should be calculated, a general theory of Zemach and Glauber for the differential cross section with respect to energy and angle for low energy neutrons interacting with a moderating medium has been specialized to the case of a gas composed of molecules which are "semi-rigid" in that vibration-rotation interactions can be neglected. The equa-

tions are such that limiting conditions of large molecular mass and moment of inertia can be investigated. The equations valid in this case may be of some use in studying liquid moderators composed of heavy molecules. (auth)

### 13133 NP-8558

Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems.

#### TRIPLE PROTON SCATTERING AT 660 MEV. II. ANGULAR DEPENDENCE OF DEPOLARIZATION PARAMETER

Yu. P. Kumeikin, M. G. Mescheryakov, S. B. Nurshv, and G. D. Stoleto. 1959. 8p. (P-440).

The results of measurement of the depolarization parameter in polarized proton beam scattering by protons at angles of 54, 72, 108, and 126° in the center-of-mass system are reported. In scattering at angles of 54, 72, and 90°, the normal component of proton beam polarization changed only slightly. The sum and the difference of depolarization parameter values for scattering angles symmetrical relatively to the direction of 90° were interpreted in terms of the amplitudes of the pp-scattering matrix. (For Part I see NSA, Vol. 13, abstract No. 4974.) (auth)

### 13134 NP-8587

Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy.

#### ELASTIC PROTON-PROTON SCATTERING AT 8.5 BEV.

P. K. Markov, M. G. Shafranov, B. A. Shabbazyan, and E. N. Tzyganov. 1959. 9p. (D-452).

Elastic p-p scattering at 8.5 BeV was investigated by the emulsion method. A beam of incident protons was directed perpendicularly to the emulsion plane. There were found 145 events of elastic scattering. The contribution of the scattering events on quasi-free protons and of other background events is 1%. The elastic scattering cross section is found to be  $8.6 \pm 0.8$  mb. The differential cross section up to 1° in the cms was obtained. The results are inconsistent with a model of a purely absorbing proton. The calculations made according to a model of a uniform sphere show that it is possible to obtain an agreement with the experimental data by the following parameters:  $R = (1.5 \text{ to } 1.7) \cdot 10^{-13}$  cm,  $K = (0.19 \text{ to } 0.12) \cdot 10^{13}$  cm<sup>-1</sup>,  $K_1 = (0.15 \text{ to } 0.12) \cdot 10^{13}$  cm<sup>-1</sup>, ( $u = 22$  to 34 Mev), ( $\nu = 22$  to 27 Mev). (auth)

### 13135 UCRL-5019

California. Univ., Livermore. Radiation Lab.

#### ANGIE, A TWO DIMENSIONAL, MULTIGROUP, NEUTRON

DIFFUSION REACTOR CODE FOR IBM 704. Richard

Stuart and Stuart Stone. [1957]. 37p. OTS.

A description of ANGIE code is presented. This code is expected to be used in two-space dimensional V-Z multi-group reactor applications. Basic equations are developed and the general features of the code are outlined. (J.R.D.)

### 13136 WAPD-BT-17(p.19-22)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

#### EXPERIMENTAL VERIFICATION OF NEUTRON ATTENUATION KERNELS. K. Shure. 4p.

Comparison is made between experimental neutron flux distributions in homogeneous media and calculations using exponential representations of the point attenuation kernel for neutrons in water. Good agreement was obtained. Verification of the validity of the point kernels and their exponential representation was provided. (auth)

### 13137 WAPD-BT-17(p.65-8)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

#### ANISOTROPY IN THE SLOWING DOWN OF NEUTRONS.

H. J. Amster. 4p.



It is shown that a single Legendre component of the "slowing in density" involves only that of both the vector flux and a directional slowing down density, which can be obtained from a modified Greuling-Goertzel equation with finite coefficients. Numerical tables for transforming Legendre components of scattering cross sections in the center-of-mass system to those in the laboratory system are furnished. Such material should be helpful in calculating rapid solutions to the neutron transport equation when the vector flux is highly anisotropic. (auth)

## 13136

ON THE MASS SPECTRUM OF SIGMA MESONS. N. Fin-cinc and C. Potoceanu. Acad. rep. populare Romîne, Inst. Fiz. atomică și Inst. fiz., Studii cercetări fiz. 9, 181-4 (1958). (Translated from Referat. Zhur. Fiz. No. 8, 1959, abstract No. 17248).

The method of constant arc was used to determine the masses of the following negative mesons, stopped in emulsion: 25 sigma mesons, producing stars with 1, 2, and 3 prongs, 19 sigma mesons producing stars with 4 and 5 prongs, and 13 pions producing  $\pi^- \rightarrow \mu$  decays. Only two particles,  $\sigma_4$  and  $\sigma_5$ , were found, whose masses gave values shifted toward 500  $m_e$  within the limits of permissible errors. Both trajectories are short and the measurements of the gaps show that these particles are pions.

## 13139

ON THE DECAY OF POSITIVE K MESONS. P. Suranyi (Central Research Inst. of Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung. 8, 447-9 (1958). (Translated from Referat. Zhur. Fiz. No. 8, 1959, abstract No. 17260).

## 13140

MOMENTUM SPACE REPRESENTATION AND PHOTODIS-INTEGRATION OF THE DEUTERON. Kiu S. Suh (Cornell Univ., Ithaca, N. Y.). Am. J. Phys. 28, 327-32(1960) Apr.

The momentum space representation is discussed in general and an application is made, deriving the cross section of the photodisintegration of the deuteron, using the Hulthen wave function. The theoretical results are compared with the experimental values and the Hulthen wave function parameter is determined. (auth)

## 13141

CONSTRUCTION OF WAVE EQUATIONS BY ERIKSSON'S SPINOR FORMALISM. Bengt Enflo (Royal Inst. of Tech., Stockholm). Arkiv Fysik 16, 469-77(1960). (In English)

A Lagrangian for a spin- $\frac{1}{2}$ -particle in an electromagnetic field is constructed by means of Eriksson's spinor formalism in the most general way that is possible. Although the Lagrangian is not invariant for time reversal the formalism leads to equations of the same type as the Dirac equation, except for a special choice of the parameters, where equations are obtained which seem to have no physical significance. (auth)

## 13142

DRIFT OF A CHARGED PARTICLE IN A MAGNETIC FIELD OF CONSTANT GRADIENT. P. W. Seymour (Australian National Univ., Canberra). Australian J. Phys. 12, 309-14(1959) Dec.

A simple expression for the drift velocity of a charged particle moving in an inhomogeneous magnetic field was obtained by Alfvén, who, in his first-order theory, considered the inhomogeneity as a small perturbation of a uniform field. By use of a different approach, an exact solution is obtained for the drift velocity of a charged particle moving in a magnetic field of constant gradient,

$B_z = \lambda x$ . The method easily yields as approximations Alfvén's result and the case of circular orbit, and includes the case of zero mean field, for which perturbation methods are inappropriate. (auth)

## 13143

APPLICATIONS OF THE METHOD OF QUASI-REAL PROCESSES. Paul Kessler. Compt. rend. 250, 1200-2 (1960) Feb. 15. (In French)

Two new applications of the method of quasi-real processes are described. One is to internal bremsstrahlung in the disintegration of the  $\mu$  meson. The other is to pair creation in the field of high-energy nuclei. (tr-auth)

## 13144

GENERALIZATION OF THE DEMONSTRATION OF THE DISPERSION RELATIONS. Roland Omnès. Compt. rend. 250, 1203-5(1960) Feb. 15. (In French)

A modification of the demonstration of dispersion relations is indicated for two-particle collisions in field theory. By studying directly the holomorphic region of the reaction amplitude without referring to a system of particular coordinates, the dispersion relations with fixed pulse transfer are shown in the case where the masses of incident or emitted particle are arbitrary. (tr-auth)

## 13145

DIFFERENTIAL GEOMETRY OF THE TRAJECTORIES OF CHARGED PARTICLES. Henri Figueras. Compt. rend. 250, 2143-5(1960) Mar. 21. (In French)

By use of the method of the mobile reference point, the differential study of trajectories of charged particles in a  $(g_{\alpha\beta}, F_{\alpha\beta})$  field corresponding to the pure electromagnetic field scheme is made. (tr-auth)

## 13146

APPLICATION OF SCHWINGER'S ACTION PRINCIPLE TO QUANTISE A FOURTH ORDER MESON FIELD. S. P. Misra (Ravenshaw Coll., Cuttack, India). Indian J. Phys. 33, 520-30(1959) Dec.

Schwinger's action principle is applied to the case of a fourth order meson equation proposed by Bhabha and Thirring. The method illustrates with the simplest model the difficulties of applying the action principle when the Lagrangian contains even the second order derivatives of the field operator, and gives a concrete and complete example of the generalization of the action principle when the Lagrangian contains higher order derivatives. (auth)

## 13147

ENERGY AND ANGULAR DEPENDENCE OF THE LEFT-RIGHT ASYMMETRY OF D-D NEUTRONS SCATTERED BY CARBON. P. S. Dubbeldam, C. C. Jonker, and H. J. Boersma (Vrije Universiteit, Amsterdam). Nuclear Phys. 15, 452-63(1960) Mar. (1). (In English)

The left-right asymmetry in the intensity of neutrons from the D-D reaction, scattered by carbon, was measured for deuteron energies between 300 and 500 kev, at two angles  $\Theta_{lab} = 50^\circ$  and  $22^\circ 30'$ , with a gold "drive-in" target. The polarization vector was turned by the magnetic field of a solenoid, and the detectors remained in a fixed position. From the comparison of the computed energy average of the effect with the experimental values it follows that the analyzing properties of  $C^{12}$  derived from the phase analysis of Meier et al., give a much better agreement than those according to Wills et al. The experiments could not decide upon the possible existence of a  $\sin 4\theta_l$  dependence of the differential polarization of the D-D neutrons. From the energy dependence of the differential polarization taken

from other authors it follows that, within the limits of the description of the D-D reaction by Beiduk, Pruett, and Konopinski, indeed other non-central forces besides the tensor force are present in the nucleon-nucleon interaction. (auth)

### 13148

NON-ELASTIC COLLISIONS OF FAST  $\pi$  MESONS WITH NUCLEONS AND PERIPHERAL ( $\pi\pi$ ) INTERACTIONS. V. S. Barashenkov (Joint Inst. for Nuclear Research, Dubna, USSR). *Nuclear Phys.* **15**, 486-94(1960) Mar. (1). (In English)

A model of central and peripheral pion-nucleon collisions is discussed on the basis of ( $\pi^-p$ )-collisions at  $E = 5$  Bev. The asymmetry of angular distribution of produced particles observed in experiments may be explained on the assumption that the cross-section of peripheral collisions constitutes  $\approx 20\%$  of the total cross-section of ( $\pi^-p$ ) collisions. An estimate  $\sigma_{\pi\pi} \approx \sigma_{\pi N}$  is obtained for the cross-section of ( $\pi\pi$ ) interactions at  $E \approx 1$  Bev. Angular asymmetry of strange particles produced in ( $\pi^-p$ ) collisions is discussed. (auth)

### 13149

POLARIZATION IN PROTON-PROTON SCATTERING NEAR 3.3 Mev. I. Alexeff and W. Haerberli (Univ. of Wisconsin, Madison). *Nuclear Phys.* **15**, 609-25(1960) Mar. (2). (In English)

The polarization in proton-proton scattering was measured for energies near 3.3 Mev and scattering angles of  $\theta_{c.m.} = 30^\circ, 45^\circ$ , and  $53^\circ$ . The purpose of the experiment was to remove some of the ambiguities in the proton-proton scattering phase shifts at low energies. Protons were first scattered from gaseous hydrogen. The scattered protons were then scattered from helium, and the right-left asymmetry was measured by means of two counter telescopes. The gas density of the helium target was increased locally by cooling with liquid air. Corrections on the observed polarization of up to 0.6% were applied to compensate for a number of experimental effects. The following values for the polarization were found:  $\theta_{c.m.} = 30^\circ$ ,  $P = (0.07 \pm 0.16)\%$ ;  $\theta_{c.m.} = 45^\circ$ ,  $P = (0.25 \pm 0.16)\%$ ;  $\theta_{c.m.} = 53^\circ$ ,  $P = (0.58 \pm 0.24)\%$ . These values are averages of measurements at slightly different proton energies. The errors are standard deviations and include all known uncertainties. (auth)

### 13150

SLOWING DOWN OF NEUTRONS. T. Teichmann (Lockheed Aircraft Corp., Sunnyvale, Calif.). *Nuclear Sci. and Eng.* **7**, 292-4(1960) Apr.

Application of Laplace transform methods enables calculation of the neutron collision density in a nonabsorbing medium for large and small lethargy values. As a result, it is not necessary to solve the differential equations for the collision density between collisions. (auth)

### 13151

VELOCITY DEPENDENT NEUTRON TRANSPORT THEORY. W. R. Conkie (Atomic Energy of Canada, Ltd., Chalk River, Ont.). *Nuclear Sci. and Eng.* **7**, 295-303(1960) Apr.

A method of extending the spherical harmonics method to calculation of velocity-dependent neutron transport processes is described. Application of the method is made to a variation of the Milne problem with the model of an ideal gas of unit mass for the scattering medium. The results indicate that the method can give accurate analytical expressions for the neutron density for such velocity dependent problems. (auth)

### 13152

ON THE ROLE OF THE INTERMEDIATE BOSON IN  $\mu \rightarrow e + \gamma$  DECAY. M. E. Ebel and F. J. Ernst (Univ. of Wisconsin, Madison). *Nuovo cimento* (10) **15**, 173-80(1960) Jan. 16. (In English)

The dependence of the branching ratio  $R(\mu \rightarrow e + \gamma) / R(\mu \rightarrow e + \nu + \bar{\nu})$  upon the ratio of cut-off to boson mass and upon a possible boson anomalous moment is discussed. Some of the properties of the boson are inferred from the present experimental data. (auth)

### 13153

MESIC DECAYS OF HYPERNUCLEI FROM  $K^-$ -CAPTURE. I. BINDING ENERGIES. R. Ammar, R. Levi Setti, and W. E. Slater (Univ. of Chicago) and S. Limentani, P. E. Schlein, and P. H. Steinberg (Northwestern Univ., Evanston, Ill.). *Nuovo cimento* (10) **15**, 181-200(1960) Jan. 16. (In English)

The analysis of 134 uniquely identified mesic decays yields increased accuracy in the knowledge of the binding energies of the hypernucleides  $H_{\Lambda}^3$ ,  $H_{\Lambda}^4$ He $_{\Lambda}^4$ , He $_{\Lambda}^6$ , Li $_{\Lambda}^7$ , Li $_{\Lambda}^8$ , Li $_{\Lambda}^9$ , and Be $_{\Lambda}^9$ . In addition, individual examples of the new species He $_{\Lambda}^7$ , B $_{\Lambda}^{11}$ , and B $_{\Lambda}^{12}$  are described. The present data are combined with those collected in the EFINS survey. The isotopic spin multiplet structure of the light hypernuclei is discussed with reference to the information derived from the binding energies. (auth)

### 13154

PARTICLE PRODUCTION IN 6.2 Bev p-p COLLISIONS TREATED BY A STATISTICAL MODEL. R. Hagedorn (European Organization for Nuclear Research, Geneva). *Nuovo cimento* (10) **15**, 246-68(1960) Jan. 16. (In English)

The Fermi theory of particle production is used in a rigorous and refined form in order to calculate spectra and mean particle numbers for all produced particles (i.e.,  $N$ ,  $\pi$ ,  $\bar{N}$  and strange particles) in 6.2 Bev (kin. lab.) p-p collisions. (auth)

### 13155

THE EFFECT OF MULTIPLE SCATTERING IN THE PHOTOPRODUCTION OF CHARGED MESONS AT DEUTERIUM. N. MacDonald (The University, Glasgow). *Nuovo cimento* (10) **15**, 301-3(1960) Jan. 16. (In English)

The multiple scattering correction to the impulse approximation treatment of the photoproduction of charged pions at deuterium was calculated. Results from these calculations were obtained for 300-Mev gamma rays. Comparison with experiment is hampered in that most experiments were conducted not with monoenergetic  $\gamma$  rays but with a bremsstrahlung spectrum. In the case of  $\pi^-D$  scattering, it was estimated that double scattering provides the major part of the multiple scattering correction. (B.O.G.)

### 13156

CROSS SECTIONS OF REACTIONS PRODUCED BY HIGH ENERGY NEUTRINO BEAMS. N. Cabibbo and R. Gatto (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). *Nuovo cimento* (10) **15**, 304-10(1960) Jan. 16. (In English)

The results of an investigation of the reactions initiated by high-energy neutrinos are presented. The cross section was suspected to increase as the energy increased, but from the derivation for one of the reactions, it was found that the cross section tends to remain constant. An estimate was made of the cross section and of its behavior with energy, by utilizing the non-renormalization hypothesis for the vector strangeness-conserving current. (B.O.G.)



## 13157

ON THE MATRIX FORMULATION OF THE THEORY OF PARTIAL POLARIZATION IN TERMS OF OBSERVABLES. G. B. Parrent, Jr. and P. Roman (The University, Manchester, Eng.). *Nuovo cimento* (10) **15**, 370-88(1960) Feb. 1. (In English)

The coherency matrix of a quasi-monochromatic plane wave is deduced from a matrix representation of the analytic signal associated with the electric field. It is shown that if the radiation passes through a physical device, such as a compensator, absorber, rotator, or polarizer, the effect of this interaction can be fully described in terms of appropriately chosen operators which transform directly the coherency matrix. The complex degree of coherence is defined in terms of the operators mentioned above, and from this is deduced an expression characterizing the degree of polarization. It is shown that the quantity deduced in this manner is identical with that obtained from the more conventional definition. An experiment is described which can serve to measure the components of the correlation matrix. (auth)

## 13158

FORMULATION OF THE CAUSALITY REQUIREMENT. J. G. Taylor and J. S. Toll (Univ. of Maryland, College Park). *Nuovo cimento* (10) **15**, 389-94(1960) Feb. 1. (In English)

A recently published formulation of the causality requirement is considered. This formulation is shown to differ in important respects from the usual requirement of "no output before input" and certain difficulties of physical interpretation are discussed. The formulation is shown to be more restrictive than the usual strict causality and to exclude bound states and certain types of resonances that occur in theories of physical interest. The discussion of the Klein-Gordon wave in terms of the characteristic momentum variable is analyzed further and the way in which the formulation leads to a physically unacceptable extension of the domain of analyticity is described. (auth)

## 13159

A NEW DERIVATION OF THE STATISTICAL THEORY OF PARTICLE PRODUCTION WITH NUMERICAL RESULTS FOR p-p COLLISIONS AT 25 Gev. R. Hagedorn (European Organization for Nuclear Research, Geneva). *Nuovo cimento* (10) **15**, 434-61(1960) Feb. 1. (In English)

A new derivation of the statistical model for particle production is given, starting from S-matrix theory. This derivation shows clearly where the heuristic arguments come in and which are the weak points. The angular isotropy in the center-of-mass system is neither a consequence nor a pre-supposition of the statistical theory; the results of such a theory merely refer to averages over all angles in the CM-system. The central collision theory may give agreement with experiments for many interesting quantities (as experience shows for 2.75 and 6.2 Bev). A more detailed differentiation of the notion of inelasticity is proposed. Spectra and mean production numbers for 25 Bev p-p collisions are given in form of curves. (auth)

## 13160

NOTE ON THE HIGH-ENERGY TAIL OF THE PION AND  $\gamma$ -SPECTRA IN p-p COLLISIONS AT 25 Gev. R. Hagedorn (European Organization for Nuclear Research, Geneva). *Nuovo cimento* (10) **15**, 462-4(1960) Feb. 1. (In English)

The energy distribution of high energy pions emerging from p-p collisions at 25 Bev is estimated using the statistical model. Instructions for the calculation of the  $\gamma$ -spectrum from these data are given. (auth)

## 13161

PION CLOUD EFFECTS IN PION PRODUCTION EXPERIMENTS. F. Bonsignori and F. Selleri (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). *Nuovo cimento* (10) **15**, 465-78(1960) Feb. 1. (In English)

A simple model is proposed for the study of single pion production in collisions of a generic particle "a" on a target nucleon. The model neglects all interactions but the one between the incoming particle and a single pion of the nucleon cloud. Application to a recent pion production experiment in proton-proton collision by the Birmingham group gives support to the idea. Another application to the experiment by the Bologna group gives qualitative evidence of pion-pion interaction. Experimental data suggest a pion-pion cross section of the order of ten millibarns. Finally an experiment is proposed which could give more detailed information on pion-pion interaction. (auth)

## 13162

A NOTE ON QUASI-ELASTIC PHOTON-DEUTERON SCATTERING. P. Federbush (Massachusetts Inst. of Tech., Cambridge). *Nuovo cimento* (10) **15**, 479-80(1960) Feb. 1. (In English)

The question of corrections to the impulse approximation of quasi-elastic  $\gamma$ -d scattering is examined in a certain energy range. The problem of obtaining the correct low-energy limit is avoided by using simple perturbation theory, which allows a single meson to be exchanged by the nucleons as a correction. The scattering amplitude obtained in this way at low energy approaches a value larger than the Thomson deuteron or proton limit. The differential cross section with averaged polarization is given. With certain assumptions, the angular function is the same as that of the Thomson amplitude. Results from  $\gamma$ -d scattering at  $\sim 90$  Mev give deviations from the impulse approximation larger than those from the calculations. (D.L.C.)

## 13163

A POSSIBLE EXPLANATION FOR THE MULTI-NUCLEON  $K^-$  CAPTURE. G. Alexander, Y. Eisenberg, and D. Kesler (Weizmann Inst. of Science, Rehovoth, Israel). *Nuovo cimento* (10) **15**, 484-6(1960) Feb. 1. (In English)

A possible two-step process for multi-nucleon  $K^-$  capture is suggested: (1) the  $K^-$  is absorbed by a single nucleon forming a resonant state,  $\Sigma^*$ , and (2) this state interacts with another nucleon giving a two-hyperon final state. In order that (2) may come about, a relatively long lifetime must be assumed for the resonant state. This process is supported by the fact that multi-nucleon capture occurs mostly with the heavy elements. Since experimental data indicate that  $K^-$ -N interaction at low energies proceeds chiefly through the  $T = 0$  channel, the resonant state should have zero isotopic spin and therefore should be formed in  $K^-$  captures by protons only. Multi-nucleon reaction rates for such a case are given. These rates indicate that the reaction ratios  $\Sigma^-p/\Sigma^+n$  and  $\Lambda^0n/\Lambda^0p$  should be equal to  $n/(p-1)$ , or 1.3 for the heavy emulsion nuclei; the frequency of the yield of  $\Sigma^-n$  is very small compared with that of  $\Sigma^-p$ ; and the ratio  $\Sigma^-p/\Sigma^+n$  is  $\sim 1.5$ . This process also predicts that these ratios should be energy independent. (D.L.C.)

## 13164

THE INFLUENCE OF THE ANOMALOUS MOMENTS OF THE BARYONS IN THE DECAY OF  $\pi^0$  IN TWO  $\gamma$  RAYS. A. H. Zimerman (Instituto de Fisica Teórica, São Paulo, Brazil). *Nuovo cimento* (10) **15**, 492-5(1960) Feb. 1. (In English)

The influence of the anomalous magnetic moments of

hyperons on the  $\pi^0 \rightarrow 2\gamma$  decay is calculated, using fermion-electromagnetic field and meson-hyperon field hamiltonians and the matrix element corresponding to the decay. The photons are shown to be polarized perpendicularly to each other. The expression for the corrected lifetime is  $\tau' = A\tau$ , where  $\tau = \sim 4.5 \times 10^{-17}$  second. The value for A is calculated to be  $\sim 1/15$ , corresponding to Gell-Mann's model, and  $\sim 3.2$ , corresponding to Tiomno's model. The factor between these values is considerably larger than that which would be obtained if anomalous moments of hyperons were not considered. Two other and more general values for A are also given. It is concluded that more experimental data from meson-hyperon interactions are needed. (D.L.C.)

### 13165

AN ESTIMATE OF THE CROSS SECTION FOR PRODUCTION OF POSITIVE K-MESONS BY ELECTRONS. G. Zanchi (Università, Pisa, Italy). *Nuovo cimento* (10) 15, 508-9(1960) Feb. 1.

The cross section for electroproduction of  $K^+(e + p \rightarrow e + \Lambda^0 + K^+)$  is estimated by using the cross section for photoproduction of K. Taking the coupling constant to be  $(G/4\pi)^2 \sim 2.9$ , the cross section is found to be  $3.65 \times 10^{-33}$  cm<sup>2</sup> for 1022 Mev. (D.L.C.)

### 13166

A SURVEY OF RELATIVISTIC TRANSFORMATIONS. M. F. Kaplan and T. Yamanouchi (Univ. of Rochester, N. Y.). *Nuovo cimento* (10) 15, 519-36(1960) Feb. 16. (In English)

The usefulness of invariance properties in calculating various kinematical quantities relevant to particle physics is outlined and examples given. General formulas relating to the transformation of distributions from one Lorentz system to another are given and their uses demonstrated. Application is made to the  $\gamma$ -ray distribution arising from  $\pi^0$ -decay. (auth)

### 13167

A SOLUBLE MODEL IN FIELD THEORY. II. UNSTABLE PARTICLE AND BOUND STATE DESCRIPTION. E. Kazes (Pennsylvania State Univ., University Park). *Nuovo cimento* (10) 15, 537-50(1960) Feb. 16. (In English)

A generalization of the Lee model was previously given with the restriction that the free and complete Hamiltonians possess the same stable one particle states. The model is applied to the calculation of unstable particle production and decay without separating the two processes. The model predicts bound state production for suitable cut-off functions. The Nishijima-Zimmermann formalism for handling bound states in conjunction with dispersion relations is shown to produce direct calculations. (For part I see *NSA*, Vol. 14, abstract number 7070). (C.J.G.)

### 13168

ELASTIC SCATTERING  $\pi^- + p$  AT 915 MeV. S. Bergia, L. Bertocchi, V. Borelli, G. Brautti, L. Chersovani, L. Lavatelli, A. Minguzzi-Ranzi, R. Tosi, P. Waloschek, and V. Zoboli (Università, Bologna; Università, Trieste, Italy; Istituto Nazionale di Fisica Nucleare, Bologna; and Istituto Nazionale di Fisica Nucleare, Trieste, Italy). *Nuovo cimento* (10) 15, 551-64(1960) Feb. 16. (In English)

The differential cross-section for elastic scattering  $\pi^- + p$  was determined on the basis of 1,421 events observed in a propane bubble chamber. The angular distribution presents a backward bump ( $\theta > 90^\circ$ ) of  $(31.5 \pm 1.3)\%$ . The amplitude at  $0^\circ$  obtained by extrapolating the angular distribution by means of a least squares fit is compared with the value obtained from the dispersion

relations and the optical theorem. Values of the pion-proton cross-sections were taken into account for the dispersion relation integrals. Using the same best fit of the angular distribution, a value for the interaction radius is obtained from considerations based on the diffraction scattering part. (auth)

### 13169

PHENOMENOLOGICAL POTENTIAL FOR  $\pi$ -p SCATTERING IN THE 1 GeV REGION. M. Chrétien (Brandeis Univ., Waltham, Mass.). *Nuovo cimento* (10) 15, 565-70 (1960) Feb. 16. (In English)

It is shown that a nuclear potential with a repulsive core can quantitatively describe the large backward scattering observed in  $\pi^-$ -p scattering for pion energies around 1 Bev. With an infinite repulsive core ( $V = \infty$  from 0 to r), surrounded by a complex well ( $V = V_r + iV_i$  from r to R) a phase shift calculation gave best agreement with experiment for  $R = 1.1 \times 10^{-13}$  cm,  $r/R = 0.2$ ,  $V_r = -60$  Mev, and  $V_i = -40$  Mev. (auth)

### 13170

ON THE DETERMINATION OF THE MAGNETIC MOMENT OF THE  $\Lambda^0$ . N. Schmitz (Max-Planck-Institut für Physik und Astrophysik, Munich). *Nuovo cimento* (10) 15, 614-23 (1960) Feb. 16. (In English)

In the presence of a magnetic field, the polarization vector of the  $\Lambda$ 's from the reaction  $\pi^- + p \rightarrow \Lambda^0 + K^0$ , precesses about the field direction and the angular distribution of the decay pions are modified. Expressions of the angular distributions for several cases were worked out. Some numerical data are given for the magnitude of the effect which depends on the field strength and the magnetic moment of the  $\Lambda^0$ . Formulas are presented from which the magnitude and sign of the  $\Lambda$  magnetic moment can be determined from experimental distributions. (auth)

### 13171

SIMPLE MODELS FOR ASSOCIATED PRODUCTION IN PROTON-PROTON COLLISIONS. E. Ferrari (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). *Nuovo cimento* (10) 15, 652-7(1960) Feb. 16. (In English)

The process  $p + p \rightarrow \Lambda^0 + K^+ + p$  is investigated by means of two simple models in which only the contribution of poles due to the exchange of an intermediate  $\pi^0$ -meson or  $K^+$ -meson, respectively, is taken into account. The total cross section is calculated in terms of the total cross-sections for simpler processes. Numerical values are given for an energy of 3 Bev of the incident proton in the l.s. (auth)

### 13172

A POSSIBLE METHOD OF SPECIFIC CHARGE IDENTIFICATION FROM PROFILE MEASUREMENTS IN NUCLEAR EMULSIONS. R. G. Ammar (Univ. of Chicago). *Nuovo cimento* (10) 15, Suppl. No. 2, 181-92(1960). (In English)

A discussion is given of a method of specific charge identification in nuclear emulsions (e.g., 1200  $\mu$ m thick K-5 pellicles processed unmounted) requiring  $\sim 50$   $\mu$ m projected range. Using a constant cell length t, the width of the track  $T_n$  was measured at each residual range nt, yielding a distribution  $\{T_n\}$ . Typically  $\{T_n\}$  consisted of 100 measurements made at a basic cell length  $t \approx 0.57$   $\mu$ m. Each track was subjected to about three such measurements in order to estimate the measurement errors. The mean  $\bar{T}$  and standard spread  $\sigma$  of this distribution, which are conventional charge sensitive parameters, often require normalizations for best results. A search amongst the dimensionless parameters associated with the distribution  $\{T_n\}$  indicates that the third moment of the distribution,



$\alpha_3 \equiv \sum_n (T_n - \bar{T})^3 / \sigma^3$ , is a charge sensitive parameter. A truncated distribution  $\{T_n\}$  with mean  $\bar{T}$ , spread  $\sigma$  and skewness  $\alpha(p\sigma')$  is derived from  $\{T_n\}$  by replacing all  $T_n > \bar{T} + p\sigma'$  by  $\bar{T} + p\sigma' \cdot \alpha(p\sigma')$  with  $p = 3.75$  is found to be the most sensitive parameter of those tried. It is presumed that its ability to discriminate is based on the presence of sub  $\delta$ -rays and the tendency to form gaps. The principal limitation arises at present from the rather large measurement errors. The observed efficiency of discrimination ( $\sim 80\%$ ) is consistent with what would be expected from these errors only. The possibility of utilizing  $\alpha$  together with the mean track thickness in order to infer the mass of the particle, is discussed. (auth)

### 13173

ATOMIC PHOTOELECTRIC EFFECT AT HIGH ENERGIES. R. H. Pratt (Univ. of Chicago). *Phys. Rev.* **117**, 1017-28 (1960) Feb. 15.

Total cross sections are obtained for the photoelectric effect from the K shell of an atom of arbitrary charge, in the limit of high energies. An approximate analytic formula then is deduced to cover the entire high-energy region. For heavy elements and very high energies the differences from previous predictions are large. These results also apply to other processes, including the one photon annihilation of fast positrons. (auth)

### 13174

SLOW-NEUTRON SCATTERING BY ROTATORS. [PART] II. Howard C. Volkin (National Aeronautics and Space Administration, Cleveland). *Phys. Rev.* **117**, 1029-36 (1960) Feb. 15.

The methods developed in a previous paper for extending the neutron scattering formalism of Zemach and Glauber to any type of molecular rotator were employed to derive generalized forms of the differential cross sections for rotator scattering. A mass-ratio expansion for the treatment of the high-energy limit is employed in the treatment of the general quantum-mechanical expression for the differential cross section. The results apply to an arbitrarily asymmetric rotator. The very low energy approximation is carried out for the symmetric rotator, and the procedure is compared with the explicit summing of the partial cross sections for individual rotational transitions. The inelastic correction to the static approximation for interference scattering is calculated to an accuracy of first order in the mass ratios for the case of the symmetric rotator. (auth)

### 13175

ALPHA-ALPHA SCATTERING IN THE RANGE 36.8 TO 47.3 MEV. Homer E. Conzett, George Igo, Harlan C. Shaw, and Rodolfo J. Slobodrian (Univ. of California, Berkeley). *Phys. Rev.* **117**, 1075-9 (1960) Feb. 15.

Absolute differential cross sections for the elastic scattering of alpha particles from helium were obtained at 36.8, 38.8, 40.8, 41.9, 44.4, 46.1, 47.1, and 47.3 Mev. Measurements were made at intervals of 2 degrees over an angular range from about 15 to beyond 90° in the center of mass system. The angular distribution shows a single minimum at 65° at the two lowest energies, and two minima, at about 35 and 70°, at the other energies. (auth)

### 13176

OPTICAL MODEL ANALYSIS OF THE SCATTERING OF ALPHA PARTICLES FROM HELIUM. George Igo (Los Alamos Scientific Lab., N. Mex.; Inst. for Theoretical Physics, Heidelberg, Ger. and Max Planck Inst. for Nuclear Phys., Heidelberg, Ger.). *Phys. Rev.* **117**, 1079-85 (1960) Feb. 15.

An optical model analysis using a complex potential was made of the elastic scattering of alpha particles from helium. In the data analyzed, the bombarding energy ranges from 23.1 Mev to 47.1 Mev. The best agreement with the angular distributions taken at eight different bombarding energies was obtained when the parameters  $V$ ,  $W$ ,  $r_0$ , and  $d$  were  $-112$  Mev,  $-1$  Mev (for bombarding energies near 40 Mev),  $1.8 \times 10^{-13}$  cm, and  $0.6 \pm 0.1 \times 10^{-13}$  cm, respectively. The value  $-112$  Mev for  $V$  is an average value;  $V$  decreases by 15% when the bombarding energy is increased from 23 to 47.1 Mev. Since  $W$  is small, the central depth of the real part of the potential  $V$  has significance. This is in contrast to the scattering of alpha particles from heavier elements where the absorption is so large that the central part of the potential is not easily determined. No lower limit was placed on  $r_0$ ; however,  $r_0$  must be less than  $2.7 \times 10^{-13}$  cm. The phase shifts obtained from this analysis are in good agreement with the preliminary results of Snyder below 42 Mev. Above 42 Mev they continue to vary slowly with no new states of Be<sup>8</sup> appearing up to 47.1 Mev. (auth)

### 13177

UPPER BOUNDS ON SCATTERING LENGTHS FOR COMPOUND SYSTEMS. n-D QUARTER SCATTERING. Larry Spruch and Leonard Rosenberg (Washington Square Coll., New York and New York Univ., New York). *Phys. Rev.* **117**, 1095-1102 (1960) Feb. 15.

In the zero-energy scattering of a particle by a compound system under the conditions that (1) only one exit channel is open (elastic scattering) and (2) no composite bound state exists for the particle and the scattering system in the state of given total angular momentum, the Kohn variational principle gives an upper bound on the scattering length. This is one of several results given previously for the case of scattering by a center of force which may be taken over directly, provided conditions (1) and (2) are satisfied. As a particular application of these results, several previous calculations of the n-D quartet scattering length,  $A_Q$ , based on the Kohn principle (the method of Verde and the static approximation of Buckingham and Massey are included) are reanalyzed using the rigorous criterion that the best result is the one giving the lowest value. Further, some calculations of  $A_Q$  based on the Rubnow formulation, which do not necessarily provide a bound, are converted to the Kohn form, thereby obtaining, in addition to a bound, an improved approximation to the scattering length. Some limitations and possible extensions of the method are discussed. (auth)

### 13178

SEMI-PHENOMENOLOGICAL ANALYSIS OF THE PROCESS  $p + p \rightarrow d + \pi^+$  NEAR THRESHOLD. A. E. Woodruff (Univ. of Rochester, N. Y.). *Phys. Rev.* **117**, 1113-18 (1960) Feb. 15.

A semi-phenomenological calculation of the amplitudes for the process  $p + p \rightarrow d + \pi^+$  near threshold is presented, using phenomenological nuclear wave functions. The meson is produced by the static p-wave interaction and the resulting Galilean invariant s-wave interaction. P-wave and s-wave rescattering of the meson are included. Agreement with experiment is obtained for both p-wave production amplitudes. The Galilean-invariant interaction is insufficient to yield the observed s-wave production but the contribution of the s-wave rescattering while not well determined, is of sufficient magnitude. (auth)

### 13179

PION-ELECTRON SCATTERING CROSS SECTION AT 1.12 BEV/c. Frank S. Crawford, Jr. (Univ. of California, Berkeley). *Phys. Rev.* **117**, 1119-25 (1960) Feb. 15.

The absolute differential cross section  $d\sigma/dK$  for production of delta-ray electrons by 1.12-Bev/c negative pions incident on a 10-in. liquid hydrogen bubble chamber was measured for values of the  $\delta$ -ray kinetic energy  $K$  between 32 Mev and the kinematical upper limit of 62 Mev. The results are in agreement with the theoretical prediction of Bhabha. An integrated cross section was found to be  $\sigma(K > 32 \text{ Mev}) = 1.37 \pm 0.17 \text{ mb}$ . This exceeds the theoretical prediction of 1.17 mb by a factor  $1.17 \pm 0.15$ . The monoenergetic electron contamination of the pion beam was determined by counting electron-induced  $\delta$  rays. The monoenergetic and non-monoenergetic contributions to the muon contamination both determined by combining a determination of the number of muon-induced  $\delta$  rays with a measurement of the curvature distribution of beam tracks. The method is described in detail. (auth)

### 13180

STOPPING OF  $\pi$ -MINUS AND K-MINUS MESONS ON HYDROGEN IN NUCLEAR EMULSION. George A. Baker, Jr. (Univ. of California, Berkeley and Los Alamos Scientific Lab., N. Mex.). *Phys. Rev.* **117**, 1130-36(1960) Feb. 15.

That the experimentally observed fact that the number of  $K^-$  mesons stopping on hydrogen in nuclear emulsion is significantly larger than the number of  $\pi^-$  is shown to be consistent with other known properties of these mesons. The reason is chiefly that the zero energy  $\pi^-$ -p cross section is anomalously low. (auth)

### 13181

PION THEORY OF NUCLEAR FORCES WITH NUCLEON RECOIL. Suraj N. Gupta (Wayne State Univ., Detroit). *Phys. Rev.* **117**, 1146-51(1960) Feb. 15.

The nuclear potential between two nucleons with non-relativistic velocities in their center-of-mass system is calculated by using the relativistic pion theory and taking fully into account the effect of the nucleon recoil. The resulting potential completely disagrees with the Klein potential but differs from the Lévy potential to a lesser extent. It is shown that an expansion of the contribution of the nucleon recoil in powers of the ratio of the pion and nucleon masses leads to erroneous results. (auth)

### 13182

KINEMATICS OF GENERAL SCATTERING PROCESSES AND THE MANDELSTAM REPRESENTATION. T. W. B. Kibble (California Inst. of Tech. Pasadena). *Phys. Rev.* **117**, 1159-62(1960) Feb. 15.

The kinematics of an arbitrary process involving two incoming and two outgoing particles is studied in terms of the invariants used in Mandelstam's representation, treating the three processes described by the same Green's function simultaneously. It is shown that the physical regions for these processes are bounded by a cubic curve in the plane of the two independent invariants. The unitarity conditions are discussed in the approximation of neglecting intermediate states of more than two particles. The formula for the spectral functions of the double dispersion relation is obtained explicitly in terms of the invariants chosen. (auth)

### 13183

SPACE-TIME CORRELATION FUNCTION FORMALISM FOR SLOW NEUTRON SCATTERING. P. Schofield (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Phys. Rev. Letters* **4**, 239-40(1960) Mar. 1.

Using Van Hove's expression which correlates the partial differential cross section for slow neutron scattering to the space-time correlation function,  $G(\vec{r}, t)$ , a

dispersion relation relating the real and imaginary parts of  $G(\vec{r}, t)$  was derived. (C.J.G.)

### 13184

$\pi^+$ -p TOTAL CROSS SECTIONS IN THE RANGE 450 Mev TO 1650 Mev. Thomas J. Devlin, Barry C. Barish, Wilmot N. Hess, Victor Perez-Mendez, and Julius Solomon (Univ. of California, Berkeley). *Phys. Rev. Letters* **4**, 242-4(1960) Mar. 1.

The total cross section at 450 to 1650 Mev for  $\pi^+$  mesons on protons was measured. Peaks in the  $\pi^-$  cross section were observed at  $600 \pm 15$  and  $900 \pm 15$  Mev and in the  $\pi^+$  cross section at 1350 Mev. (C.J.G.)

### 13185

QUESTION OF THE EXISTENCE OF A STRANGENESS 2 MESON. D. J. Prowse (Univ. of California, Los Angeles). *Phys. Rev. Letters* **4**, 244-6(1960) Mar. 1.

Previous reports on the existence of a strangeness 2 meson with a mass of about 720 Mev were analyzed. It is concluded that evidence for the existence of such a particle is lacking and certainly not provided by anomalous  $K^+$  decays which were used to explain its existence. (C.J.G.)

### 13186

PARTIAL-WAVE DISPERSION RELATIONS FOR MESON-NUCLEON SCATTERING. Rienhard Oehme (Univ. of Chicago). *Phys. Rev. Letters* **4**, 246-7(1960) Mar. 1.

Partial-wave dispersion relations were used to calculate the pion-nucleon scattering amplitude of possible resonance effects in the two-pion system. (C.J.G.)

### 13187

FURTHER INTERPRETATION OF A MEDIUM ENERGY (p,2p) EXPERIMENT. A. J. Kromminga (Univ. of Minnesota, Minneapolis) and I. E. McCarthy (Univ. of California, Los Angeles). *Phys. Rev. Letters* **4**, 288-90(1960) Mar. 15.

The momentum transfer distribution observed in the 40-Mev (p,2p) angular correlation experiment of Griffiths and Eisberg is discussed. The small momentum transfers observed in the experiment are considered to be essentially due to the anisotropy of the momentum distribution and the fact that the interaction does not effectively occur uniformly throughout the nuclear surface. (C.J.G.)

### 13188

R PARAMETER IN p-p SCATTERING AT 142 MEV. L. Bird, D. N. Edwards, B. Rose, A. E. Taylor and E. Wood (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Phys. Rev. Letters* **4**, 302-3(1960) Mar. 15.

A measurement was made of the Wolfenstein R parameter in p-p triple scattering at 142 Mev for angles 24.0 to 90.0° (the angle for horizontal transverse polarization of scattered protons in the horizontal plane). (C.J.G.)

### 13189

POSSIBLE NEW RESONANCE IN THE  $\pi^+$ -p SYSTEM. Peter Carruthers (Cornell Univ., Ithaca, N. Y.). *Phys. Rev. Letters* **4**, 303-6(1960) Mar. 15.

A discussion of previously reported data on the  $\pi^+$ -p system which suggest the existence of a new resonance in the isotopic spin 3/2 ( $\pi^+$ -p) state at an energy of about 850 to 950 Mev is presented. (C.J.G.)

### 13190

FEASIBILITY OF USING HIGH-ENERGY NEUTRINOS TO STUDY THE WEAK INTERACTIONS. M. Schwartz (Columbia Univ., New York). *Phys. Rev. Letters* **4**, 306-7(1960) Mar. 15.

The feasibility of using high-energy neutrinos to study



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weak interactions is discussed. It is proposed that the high-energy neutrinos be obtained from pion decay, the pions being produced by proton reactions. (C.J.G.)

13191

THEORETICAL DISCUSSIONS ON POSSIBLE HIGH-ENERGY NEUTRINO EXPERIMENTS. T. D. Lee (Columbia Univ., New York) and C. N. Yang (Institute for Advanced Study, Princeton, N. J.). *Phys. Rev. Letters* **4**, 307-11(1960) Mar. 15.

The theoretical implications of using high-energy neutrinos to study weak interactions are discussed. Such implications considered are: identity of the neutrinos; conservation of leptons; point structure of lepton current; universality of weak interactions involving  $e^+$  and  $\mu^+$ ; S-symmetry; and possible existences of a neutral lepton current and a weakly coupled boson  $W^\pm$ . (C.J.G.)

13192

PION FORM FACTORS FROM POSSIBLE HIGH-ENERGY ELECTRON-POSITRON EXPERIMENTS. N. Cabibbo and R. Gatto (Università di Rome, Cagliari, Italy and Università, Rome). *Phys. Rev. Letters* **4**, 313-14(1960) Mar. 15.

Pion form factors were derived for processes of the sort expressed by the reactions  $e^+ + e^- \rightarrow n$  pions in their lowest electromagnetic approximation. (C.J.G.)

13193

EFFECTS OF PION-PION INTERACTION IN ELECTROMAGNETIC PROCESSES. L. M. Brown (Università, Rome) and F. Calogero (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). *Phys. Rev. Letters* **4**, 315-17 (1960) Mar. 15.

Frazer and Fulco previously derived an electromagnetic form factor for the pion in pion-pion scattering which exhibits a resonance-like behavior as a function of the invariant momentum transfer. The effect of this pion form factor on the photon propagator was calculated. Corrections of order  $e^2$  to several purely electromagnetic processes were obtained. (C.J.G.)

13194

THE OPTICAL MODEL OF LIGHT NUCLEI. P. B. Jones (Univ. of Oxford). *Proc. Roy. Soc. (London)* **A255**, 253-66(1960) Apr. 5.

A derivation of the optical model operator is presented for a nucleus of any mass number  $A \geq 1$ . The special case of  $A = 1$  is considered. The formalism is extended to include compound incident particles, and particles such as  $K^-$  mesons. An approximate evaluation was made for  $K^+ - \text{He}^4$  elastic scattering at a number of energies. Both real and imaginary parts of the potential are non-local. The radial dependence of each non-locality was calculated. The accuracy of the impulse approximation for  $K^+ - \text{He}^4$  scattering was investigated. Correlations in the  $\text{He}^4$  ground-state wave function are shown to be important in the interpretation of both the empirical local optical model potential and the charge distribution determined by high-energy electron scattering. (auth)

13195

ON THE COLLECTIVE ENERGY LOSS MECHANISM OF ELECTRONS PASSING THROUGH SOLIDS. Mitsuo Watabe (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)* **22**, 447-8(1959) Sept. (In English)

A new approach to the collective energy loss mechanism for electrons passing through solids is presented. Use is made of the high-density-limit theory results of Sawada et al. to study the limiting case of a dense electron gas.

The calculation is made for the transition probability of an incident fast electron being scattered by exciting the electron gas from its ground state to the one-plasmon state. (B.O.G.)

13196

DETERMINATION OF VELOCITY DISTRIBUTION OF ELECTRONS FROM OBSERVED SPECTRAL DISTRIBUTION OF BREMSSTRAHLUNG. Mehendra Singh Sodha, Charles E. Stewart, and Robert F. Tooper (Armour Research Foundation, Chicago). *Progr. Theoret. Phys. (Kyoto)* **22**, 461-5(1959) Sept. (In English)

Equations are given for the determination of the cross section of collisions of a positive ion with an electron which emit a photon in the process, and the spectral distribution of bremsstrahlung per unit volume. These equations may be combined into the form:

$$F(y) = A \int_y^\infty \ln \left\{ \frac{\sqrt{x} + \sqrt{x-y}}{\sqrt{y}} \right\} N(x) dx, \text{ the solution of which}$$

gives the velocity distribution of electrons from observed spectral distribution of bremsstrahlung ( $\nu^2 N (m\nu^2/2) d\nu$ ). Another method of solution is presented for regions in which the Born approximation is valid. (B.O.G.)

13197

EFFECTS OF POTENTIAL WELL PARAMETERS ON THE POLARIZATION OF ELASTICALLY SCATTERED PROTONS. Keiichi Nishimura (Rutgers Univ., New Brunswick, N. J.). *Progr. Theoret. Phys. (Kyoto)* **22**, 465-6(1959) Sept. (In English)

An explanation is presented of the well parameters which occur in polarization experiments with high-energy nucleons when analyzed by the optical model potential method. Sternheimer studied the effects of the imaginary part of  $V_0$  on the calculated polarization of 150-Mev elastically scattered protons. Prior to this investigation an approximate expression had been developed for polarization with the use of the distorted wave Born approximation. Results are compared and agreement is reached in that all the well parameters must be changed when fitting experimental results. (B.O.G.)

13198

INVARIANCE IN ELEMENTARY PARTICLE PHYSICS. N. Kemmer, J. C. Polkinghorne, and D. L. Pursey (Univ. of Edinburgh). *Repts. Progr. Phys.* **22**, 368-432(1959).

An account is given of the invariance properties that have important applications in elementary particle physics. These can be classified in several ways. Firstly, some are related to continuous groups (rotations), others to discrete groups (inversions). Secondly, some are related to groups of well-known geometrical or kinematical significance (ordinary space time), others are not and are peculiar to elementary particle physics (isobaric space). Finally, some are rigorously valid while others are of approximate nature. The discussion aims to cover all cases and their interpretation. In as far as possible explicit use of quantum field theory techniques is avoided. (auth)

13199

THE TWO-NUCLEON INTERACTION. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Repts. Progr. Phys.* **22**, 562-634(1959).

A survey of the progress made in recent years toward finding and explaining the forces between two non-relativistic nucleons is presented. Phenomenology and meson field theory approaches are used. The methods and achievements for each approach are described. 350 references. (B.O.G.)

**13200**

X-RAY AND THERMAL-NEUTRON SCATTERING NEAR A SECOND-ORDER PHASE TRANSITION POINT. M. A. Krivoglaз (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). *Soviet Phys.-Cryst.* 4, 290-92(1960) Mar.

A discussion is presented of x-ray and thermal-neutron scattering near a second-order phase transition point. The scattering is considered at fluctuations in the long-range order and in the composition of monochromatic x rays in monocrystals. In the discussion scattering caused by the Compton effect, thermal oscillations, and fluctuations in short-range order are neglected. With neutrons an anomalously large magnetic scattering effect exists near the Curie point because large fluctuations occur in the magnetic moment. (B.O.G.)

## Nuclear Properties and Reactions

**13201** AERE-R-3205

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE MEASUREMENT OF  $U^{238}$ : $U^{235}$  FISSION RATIOS.

M. D. Carter, A. J. Perks, and L. G. Sanders. Feb. 1960. 28p. BIS.

A method is described for measuring  $U^{238}$ : $U^{235}$  fission ratios in heterogeneous thermal reactor assemblies using aluminum disks as catcher foils and  $\beta$ -counting techniques. The assumptions implicit in the formulas which yield fission ratios from measured count-ratios are listed with comments on their validity. Experimental results for a 1.2" diameter uranium metal rod are presented to demonstrate the feasibility of the method. (auth)

**13202** AERE-R-3250

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

## SMALL SAMPLE TECHNIQUES FOR SLOW NEUTRON TOTAL CROSS SECTION MEASUREMENTS. G. S. G.

Tuckey. Feb. 1960. 8p. BIS.

The design and performance of a sample changer to be used in the small sample chopper for slow neutron total cross section measurements are discussed. A description of the sample techniques used is given, including the methods of determining the bores of the tubes and the techniques for filling the tubes with milligram quantities of material. (auth)

**13203** JLI-650-4-2

Johnston (William H.) Labs., Inc., Lafayette, Ind. OPERATING INSTRUCTIONS FOR INEXPENSIVE SOFT BETA COUNTING SYSTEM. June 1959. 30p. Contract AT(11-1)-650. OTS.

The design and operation are described of a medium low-level soft beta counting unit designed to aid in the instruction of students in the properties and uses of radioisotopes. (C.H.)

**13204** LS-42

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON (n,p) AND (n,2n) AND (n, $\alpha$ ) REACTIONS OR NUCLEAR REACTIONS WITH 14-19 MEV NEUTRONS. May 1959. 18p.

A bibliography is presented on (n,p), (n,2n), and (n, $\alpha$ ) reactions or nuclear reaction with neutrons at 14 to 19 Mev. The references were collected from *Nuclear Science Abstracts* 1948 to 1959 (March), *Physics Abstracts* 1948-1959 (Jan.), Geneva Conference Papers 1955 and 1958, US

research reports, bibliographies, and books. 190 references. (T.R.H.)

**13205** LS-44

Israel. Atomic Energy Commission, Tel-Aviv. LITERATURE SURVEY ON NUCLEAR REACTIONS AND NUCLEAR USES OF LITHIUM. Aug. 1959. 49p.

A bibliography is presented on lithium with separate sections on nuclear reactions, natural abundance ratio and isotope separation, uses in reactors, other uses, and available bibliographies. The references were collected from *Nuclear Science Abstracts* Vols. 1-12 (1948-1958) and Vol. 9, Nos. 1-10, *Chemical Abstracts* Vols. 44-52, 1950-58, and Vol. 53, Nos. 1-11, reports in Israel Atomic Energy Commission Library, and UKAEA and AERE Information Bulletins. 496 references. (T.R.H.)

**13206** NYO-8082

Princeton Univ., N. J. Palmer Physical Lab. ANGULAR DISTRIBUTIONS OF DEUTERONS FROM REACTIONS INDUCED BY 18 MEV PROTONS INCIDENT ON A FEW LIGHT NUCLEI (thesis). Edgar F. Bennett. Mar. 1958. 113p. Contract AT(30-1)-937. OTS.

Using a thin proportional counter as a velocity selector in conjunction with a sodium iodide crystal to measure energy, deuterons from proton induced reactions in some light nuclei were studied. The detection system was capable of presenting an essentially undistorted spectrum of deuterons in the presence of a background of protons of the same energy and considerably more intense. Angular distributions of deuterons from (p,d) reactions on  $C^{13}$ ,  $N^{14}$ ,  $N^{15}$ ,  $F^{19}$ ,  $Na^{23}$ ,  $Mg^{25}$ , and  $P^{31}$  were taken. Butler curves were calculated to fit the experimental distributions and reduced level widths extracted. Level widths (or more specifically ratios of level widths) were computed using shell model wave functions where sufficient information on the nuclear states involved was available, and these were checked against experiment. Generally fair agreement was found. In the course of these investigations two even parity levels were found in  $F^{19}$ , one at 1.7 Mev (1+) and the other at 4.1 Mev (2+?). A state in  $P^{30}$  at about 0.8 Mev was also found having a spin of 0+ or 1+. (auth)

**13207** ORO-259

Florida State Univ., Tallahassee. PROGRESS REPORT FOR THE FIFTH PERIOD, DECEMBER 1, 1958 TO SEPTEMBER 1, 1959. Alex E. S. Green. 141p. Contract AT(40-1)-1755. OTS.

Six papers are presented on nuclear models. Two papers were previously abstracted in NSA and separate abstracts are given for the remaining four. (W.D.M.)

**13208** ORO-259(Paper 1)

Florida State Univ., Tallahassee. SINGLE PARTICLE MOTION IN A REALISTIC NON-SPHERICAL FIELD. A. E. S. Green and R. H. Lemmer. 5p.

An investigation is presented which is aimed at (1) using a realistic form of the average nuclear field to determine the intrinsic wave functions and (2) making detailed calculations of ground state properties of nuclei in regions of mass number where the collective model is known to be applicable. (W.D.M.)

**13209** ORO-259(Paper 2)

Florida State Univ., Tallahassee. SINGLE PARTICLE STATES IN A SPHEROIDAL HARMONIC OSCILLATOR POTENTIAL WITH VELOCITY DEPENDENCE. R. H. Lemmer. 26p.

Single particle motion is considered which is described by the wave equation where  $V(r)$  is a spheroidal oscillator



potential to which a spin orbit term of the usual type is added to produce the correct single particle level scheme in the spherical limit. A brief outline of the perturbation procedure is presented, together with the resulting level scheme. The main effects of the non-local interaction in the deformed field are discussed. Calculations of nuclear equilibrium deformations and intrinsic quadrupole moments based on the energy level scheme are given. (W.D.M.)

### 13210 ORO-259(Paper 3)

Florida State Univ., Tallahassee.

NEUTRON STRENGTH FUNCTIONS IN A SURFACE ABSORPTION OPTICAL MODEL. Y. C. Tang and F. Khanna. 7p.

One of the accomplishments of the nuclear optical model at low energies has been the prediction of the average ratio of neutron width to level spacing as a function of the mass number. By using a tapered well and a volume absorption term, a theoretical curve for the S-wave strength function can be produced which fits the observed values fairly well for most A. The effect of using a surface-peaked imaginary potential on the behavior of the neutron S-wave strength function is investigated. (W.D.M.)

### 13211 ORO-259(Paper 4)

Florida State Univ., Tallahassee.

A COMPLEX NON-LOCAL DIFFUSE BOUNDARY INDEPENDENT PARTICLE MODEL OF NUCLEON-NUCLEAR SCATTERING AND BOUND STATE PHENOMENA (thesis). Philip J. Wyatt. Aug. 1959. 81p.

A unified description of the scattering and bound state phenomena over the energy range  $-50$  to  $+25$  Mev is attempted. The procedure consists of an extension and modification of some of Green's earlier bound state work to include scattering phenomena. The bound states are treated for both neutron and proton cases; however, the scattering formalism is applied almost entirely to neutrons. (W.D.M.)

### 13212 TID-5695

Pennsylvania. Univ., Philadelphia.

TOTAL GAMMA ABSORPTION IN  $C^{12}$ ,  $N^{14}$ ,  $O^{16}$ , AND  $Al^{27}$  AT 20 MEV. Technical Report No. 5. Edward E. Carrol, Jr. Sept. 1959. 130p. Contract N-onr-551 (17). OTS.

Total gamma absorption cross sections of  $C^{12}$  from 20.0 to 21.15 Mev, and of  $N^{14}$ ,  $O^{16}$ , and  $Al^{27}$  from 20.0 to 20.5 Mev, were measured using monochromatic gamma rays. A direct absorption technique was used in which samples were placed between the target of an electrostatic generator, and large sodium-iodide scintillation detectors. Monochromatic photons from the  $T^3(p,\gamma)He^4$  reaction were varied in energy by changing the energy of the incident protons. The  $C^{12}$  cross-section showed pronounced structure with resonances resolved at 20.15, 20.46, and 20.92 Mev, with integrated cross sections of 1.1, 1.0, and 6.6 Mev-millibarns, respectively. Oxygen showed a sharply rising cross section suggesting a strong resonance peaked above about 20.5 Mev. The cross-sections of  $N^{14}$  and  $Al^{27}$  were smooth over the energy interval investigated. (auth)

### 13213 TID-5700

Purdue Univ., Lafayette, Ind.

STRIPPING EFFECTS IN THE REACTIONS  $C^{12}(He^3,p)N^{14}$  AND  $C^{12}(He^3,d)N^{13}$  AT 13.9 MEV. J. R. Priest, D. J. Tendam, and E. Bleuler. [1960]. 32p. Contract [AT(11-1)-122].

Angular distributions were measured for the reactions  $C^{12}(He^3,p)N^{14}$  and  $C^{12}(He^3,d)N^{13}$  using the 14-Mev  $He^3$  cyclo-

tron beam. Reasonable fits to the angular distributions were obtained using a  $[J_L(Qr_0)]^2$  dependence. Transitions to the  $1^+$ ,  $T = 0$  and  $0^+$ ,  $T = 1$  states were considered. (W.D.M.)

### 13214 TID-5707

Purdue Univ., Lafayette, Ind.

ANGULAR DISTRIBUTIONS FOR  $C^{12}(\alpha,p)N^{15}$  AT 16.1-19.0 MEV AND  $F^{19}(\alpha,p)Ne^{22}$  AT 18.9 MEV. J. R. Priest, D. J. Tendam, and E. Bleuler. [1960]. 26p. Contract [AT(11-1)-122]. OTS.

Angular distributions were measured for the reactions  $C^{12}(\alpha,p)N^{15}$  and  $F^{19}(\alpha,p)Ne^{22}$ . The  $C^{12}(\alpha,p)$  data at 18.0, 17.1, and 16.1 Mev differ markedly from the data at 19.0, 18.7, and 18.3 Mev. For the  $F^{19}(\alpha,p)Ne^{22}$  data, the cross sections for the transition to the ground state are factors of 10 to 20 less than the cross sections for the transition to the first excited state of  $Ne^{22}$ . (W.D.M.)

### 13215 UCRL-9074

California. Univ., Berkeley. Lawrence Radiation Lab.

REMARKS ON EXCITED STATES OF EVEN-EVEN NUCLEI AND ON THE EXISTENCE OF A COMPLEX VIBRATIONAL SECOND EXCITED STATE. Horacio E. Bosch. Feb. 4, 1960. 11p. Contract W-7405-eng-48. OTS.

Different types of spectra in even-even nuclei are discussed. Properties of those nuclei for  $40 < A < 154$  and  $180 < A < 222$  are summarized. Several theoretical predictions of the existence of a complex vibrational second excited state are described and compared with experimental data. (auth)

### 13216 WAPD-BT-17(p.48-50)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

SURFACE TO VOLUME ACTIVATION BY RESONANCE NEUTRONS IN A URANIUM METAL ROD. G. G. Smith and D. Klein. 3p.

The spatial distribution for resonance neutron capture in  $U^{238}$  has previously been determined for a 1.3% enriched, 0.387-in. diam uranium rod to within 0.001 in. of the surface. A technique is described which has carried the distribution to within 0.00006 in. of the surface. With this technique, it appears probable that the interaction effect of neighboring rods can be determined by varying the lattice spacing. (auth)

### 13217 WAPD-BT-17(p.51-6)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

MULTIGROUP CROSS SECTIONS FROM DETAILED NUCLEAR DATA. H. J. Amster. 6p.

The cross sections of  $U^{238}$  have recently been tabulated with more than usual detail. They are used here for making up a fifty-four group experimental library for the MUFT Code. The procedure is presented as an example of how one could, in principle, account for fine details in all nuclear data. (auth)

### 13218 AEC-tr-3994

DIVISION OF THE NUCLEI OF THE HEAVY ELEMENTS BY THEIR INTERACTION WITH THE NUCLEI OF CARBON, NITROGEN AND OXYGEN. G. N. Flerov. Mar. 1958. Translated from Russian. 27p. JCL or LC.

Monochromatic beams of  $C^{12}$ ,  $C^{13}$ ,  $N^{14}$ , and  $O^{16}$  were obtained on a 150-cm cyclotron. The beams were used for studies of the interaction of multiple charged ions with various heavy elements. Experiments on fission and volatilization are described and results are presented. (W.D.M.)

**13219** NP-tr-414

THE FORMATION OF SELF-TARGETS FOR THE REACTION  $D(d,n)He^3$  AND ITS CONNECTION WITH THE PROBLEM OF HYDROGEN DIFFUSION IN METALS. Klaus Fiebiger. Translated by F. Hudswell (U.K.A.E.A. Atomic Energy Research Establishment) from *Z. angew. Phys.* **9**, 213-23(1957). 38p. JCL.

The formation of self-targets for the reaction  $D(d,n)He^3$  is discussed relative to the saturation of the neutron yield of the self-target. The magnitudes of the saturation value and of the change with time of the saturation process are considered. Neutron yields from 0.02 (Fe) to 0.5 (Au) of the yield from a heavy-ice target were measured at target temperatures of 20 to 50°C. The diffusion theory was found to accurately interpret the formation of self-targets, within the limits of experimental accuracy. Saturation curves are presented for Au, Fe, Ta, Ti, Ni, Zr, Pd, and Rh. Relationships between the deuteron self-target formation and the problem of the diffusion velocity of hydrogen in metals are discussed. (C.J.G.)

**13220** UCRL-Trans-518

ENERGY DISTRIBUTION OF THE FRAGMENTS OF TERNARY FISSION OF URANIUM NUCLEI UNDER THE ACTION OF NEUTRONS. V. N. Dmitriev, L. V. Drapchinskii, K. A. Petrzhak, and Yu. F. Romanov. Translated from *Doklady Akad. Nauk S.S.S.R.* **127**, 531-3(1959). 8p. (Includes original, 3p.). JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 20531.

**13221**

ON THE LEVEL STRUCTURE OF  $B^{10}$ . Juhani Kantele (Univ. of Helsinki). *Ann. Acad. Sci. Fennicae Ser. A VI* No. 37, 1-29(1959). (In English)

A new energy level at 7.42 Mev in  $B^{10}$  was found. The half-width of this level is about 100 kev, the corresponding  $Be^9(p,\gamma)B^{10}$ -resonance energy being  $930 \pm 15$  kev. The peaking of the  $(p,d)$ - and  $(p,\alpha)$ -reactions at the same energy found by other investigators is explained in terms of the 7.42-Mev level, and these modes of dissociation suggest that the level is an isobaric spin  $T = 0$ -state. Observed radiative transitions to the 0.72, 1.74, and 2.15 Mev levels together with the particle decay of the 7.42 Mev state lead to the spin and parity assignments  $1^+$  or  $1^-$  for the level, the former being more probable. The existence of the 7.47 Mev state was secured and the width of this level is about 35 kev. This level is seen to decay to the ground level and to the 0.72 and 2.15-Mev levels. Some further  $\gamma$ -rays were observed and explained in terms of energy differences between different levels in  $B^{10}$ . A decay scheme for the 7.48, 7.47, and 7.42 Mev levels is proposed and discussed. (auth)

**13222**

GAMMA-GAMMA DIRECTIONAL CORRELATION IN  $Hg^{200}$ . Z. Grabowski and B. Van Nootjen (Inst. of Physics, Uppsala). *Arkiv Fysik* **16**, 479-80(1960). (In English)

The spin of the 1885 kev level in  $Hg^{200}$  was determined by a directional correlation measurement. Using internal conversion data, it is possible to make the following assignments:  $4^-$  to the 1885 kev level,  $2^+$  to the 1595 kev level, and  $3^-$  to the 2137 kev level. (auth)

**13223**

HIGH-ENERGY GAMMA RADIATION FROM  $Ag^{110m}$ . H. W. Taylor and S. A. Scott (Queen's Univ., Kingston, Ont.). *Can. J. Phys.* **38**, 573-5(1960) Apr.

Gamma radiation from  $Ag^{110m}$  was studied in the region

1300 to 1800 kev using a scintillation counter. The gamma intensity was determined to be  $(6 \pm 2) \times 10^{-4}$  photons per disintegration. A peak at  $1730 \pm 30$  kev is reported. (C.J.G.)

**13224**

RELATIVE INTENSITY OF SOME  $\gamma$  TRANSITIONS OF ACTINIUM-227. Roger Foucher. *Compt. rend.* **250**, 1249-51(1960) Feb. 15. (In French)

The relative intensity of the  $\gamma$  radiations from the de-excitation of the 329-kev level is measured by scintillation spectrometry. From this measurement and from measurements of the  $\alpha$ - $\gamma$  and  $\gamma$ - $\gamma$  coincidences, a probable multipolarity of some  $\gamma$  transitions of  $Ac^{227}$  is deduced. (tr-auth)

**13225**

STUDY BY SCATTERING AND RESONANCE ABSORPTION OF THE 10.5 Mev LEVEL OF MAGNESIUM-24. André Bussi re de Nercy (Laboratoire de Physique nucl aire, Orsay, France). *Compt. rend.* **250**, 1252-4(1960) Feb. 15. (In French)

The angular distribution of scattered photons has a dipolar character. Some scattering and autoabsorption experiments show the cross section of nuclear absorption to be  $\sigma_a^0 = 7 \pm 2$  barns at resonance. A total length of  $\Gamma = 1.7 \pm 0.4$  kev was obtained for the level. The partial length  $\Gamma_{\gamma 0} = 180 \pm 50$  ev appears large for a level with independent particle. (tr-auth)

**13226**

THE RESONANCE EXCITATION OF METASTABLE NUCLEAR LEVELS OF VERY LONG LIFE. Christophe Tzara. *Compt. rend.* **250**, 1466-7(1960) Feb. 22. (In French)

The possibility of exciting by resonance a metastable nuclear state of moderately long life (approximately 1 min) is considered. (tr-auth)

**13227**

THE RANGE-ENERGY RELATIONSHIP OF  $Li^6$  IONS IN NUCLEAR EMULSIONS. Huu-tri Nguyen (Facult  des Sciences, Bordeaux). *Compt. rend.* **250**, 2016-18 (1960) Mar. 14. (In French)

Artificially accelerated  $Li^6$  ions are collected in Ilford C2 emulsions. Six experimental points of the range-energy curve are determined between 0.75 and 2 Mev. The results are compared with those of previous authors. (tr-auth)

**13228**

QUASI-PARTICLES AND COLLECTIVE STATES OF SPHERICAL NUCLEI. Marcel V n roni and Robert Arvieu (Laboratoire de Physique nucl aire, Orsay, France). *Compt. rend.* **250**, 2155-7(1960) Mar. 21. (In French)

The application of the Bogolyubov canonical transformation to the hamiltonian of a system of identical particles in interaction in a spherical mean potential has permitted this hamiltonian to be written in a form well adapted to the study of collective states directly from the effective interactions (*Compt. rend.* **250**, 992(1960)). In the present work the energy of the collective modes was calculated. (J.S.R.)

**13229**

RADIATIVE CAPTURE OF THERMAL NEUTRONS ON NUCLEUS. [PART] II. J. Kopeck y, J. Kajfosz, and J. Urbanec (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). *Czechoslov. J. Phys.* **10**, 119-28(1960). (In Russian)

The energies and intensities of gamma rays from the capture of a neutron in Na, Co, Zn, Ag, Te, and I nuclei at 20 to 1000 kev were measured with a single-crystal,



single-channel scintillation spectrometer. Energies of radiative transition were measured for Co, Zn, Te, and I nuclei. (auth)

### 13230

( $\gamma, p$ ) REACTION ON CADMIUM AND TIN. M. Rozkoš, M. Smrčka, and O. Jakubček (Charles Univ., Prague). Czechoslov. J. Phys. 10, 129-35(1960). (In Russian)

A study was made of the nuclear photoeffect on Sn and Cd. The shape of the energy spectrum of tin was found to correspond to the Wilkinson theory of giant resonance. For cadmium the energy spectrum was similar to the evaporation spectrum. The angular distributions of the photoprotons of both elements can be described quite well by empirical equations which contain associated Legendre polynomials of different orders. The results have features of both a direct and a collective process. (auth)

### 13231

BACKSCATTERING OF CARBON-14 BETA RADIATION. George L. Gaines, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys. 31, 741-2(1960) Apr.

The backscattering of  $C^{14}$   $\beta$  particles by various substrates was investigated in connection with studies of radiostearic acid monolayers. Comparisons were made for backscattering from  $C^{14}$  and  $Tl^{204}$  (0.76 Mev) with a mica end-window Geiger-Müller counter under conditions of similar geometry, and the absorption (in aluminum) of the backscattered radiation was measured. Slight variations in the geometry of the source or counting arrangement may lead to significant differences in the observed backscattering, especially at low-energy radiation. (B.O.G.)

### 13232

VARIATION OF GAMMA RADIATION RATES FOR DIFFERENT ELEMENTS FOLLOWING AN UNDERWATER NUCLEAR DETONATION. W. J. Heiman (U. S. Naval Radiological Defense Lab., San Francisco). J. Colloid Sci. 13, 329-36(1958) Aug.

Calculations are made of the gamma radiation rates for the 13 radioisotopes contributing the major portion of gamma radiation from a deep underwater nuclear detonation. These calculations are carried out for 14 different times after the burst ranging from 40 min to 3 years. The gamma emitters include activities induced in sea water and possible bomb components as well as fission products. (auth)

### 13233

HELICAL MODEL OF PARTICLES IN ISOSPACE. Jerzy Rayski. Magyar Fiz. Folyóirat 6, 226-37(1958). (Translated from Referat. Zhur. Fiz. No. 8, 1959, abstract No. 17276).

A new system of strongly interacting particles (pions, K mesons, nucleons, and hyperons) in isospace is discussed.

### 13234

0+ STATES OF  $Sm^{152}$  AND  $Gd^{152}$ . I. Marklund (Inst. of Physics, Uppsala) and O. Nathan and O. B. Nielsen (Univ. of Copenhagen). Nuclear Phys. 15, 199-215(1960) Feb. (2). (In English)

The decay of  $Eu^{152m}$  (9.2h) is studied by means of internal and external conversion and  $e^- - \gamma$  coincidence measurements with particular interest focused on the possible low-lying 0+ levels in the transition region between spherical and non-spherical nuclei. Such levels are now found at 615.3 keV in the near-spherical nucleus  $Gd^{152}$  and at 685.0 keV in the strongly deformed nucleus  $Sm^{152}$ . The experimental K-conversion coefficients for the 0+  $\rightarrow$  0+ transitions

are  $\geq 0.770$  and  $\geq 0.250$ , respectively. The  $a_K/\gamma$  branching ratios  $\mu$  from the 0+ levels to the ground states and to the first excited 2+ states are compared with the theoretical values:  $Gd^{152}$ :  $\mu_{exp} = 0.10 \pm 0.03$ ,  $\mu_{theory} = 0.085$ ;  $Sm^{152}$ :  $\mu_{exp} = 0.013 \pm 0.001$ ,  $\mu_{theory} = 0.13$ . (auth)

### 13235

NOTE ON ONE PION EXCHANGE POTENTIAL. G. Breit and M. H. Hull, Jr. (Yale Univ., New Haven). Nuclear Phys. 15, 216-30(1960) Feb. (2). (In English)

The phase-parameters of nucleon-nucleon scattering are worked out for the one-pion exchange potential in a way allowing localization of effects in space for each parameter. Success of phenomenologic phase-parameter fits making use of one-pion exchange values for the higher L and J is discussed in terms of the localization. It is shown that the one-pion exchange potential is probably the main interaction at distances greater than  $2.9 \times 10^{-13}$  cm. With somewhat less certainty it is concluded that it is the major interaction for  $r > 1.6 \times 10^{-13}$  cm and evidence is presented for believing that some other interaction is the principal one for  $r < 1.6 \times 10^{-13}$  cm. (auth)

### 13236

CIRCULAR POLARIZATION OF EXTERNAL BREMSSTRAHLUNG FROM  $\beta$ -RAYS IN MAGNETIZED TARGETS. A. Bisi, A. Fasana, and L. Zappa (Istituto di Fisica del Politecnico, Milan). Nuclear Phys. 15, 231-8(1960) Feb. (2). (In English)

The degree of circular polarization of the external bremsstrahlung, produced by  $\beta$ -rays from  $Y^{90}$  in magnetized targets of silver and annealed Armco iron was investigated. It was found that the polarization is greater when the momentum of the radiating electron is backward with respect to the target magnetization. The ratio of the polarizations corresponding to backward and forward momenta is nearly independent of the quantum energy and equal to  $1.33 \pm 0.09$  ( $B = 4400$  gauss) and  $1.53 \pm 0.09$  ( $B = 7000$  gauss) respectively for Ag and Fe targets. A small effect was also detected by measuring the polarization of the external bremsstrahlung produced in a weakly magnetized iron target, relative to that produced in a highly magnetized target, when the magnetization was perpendicular to the electron momentum. The ratio of the polarizations, not greater than 1.17 and also independent of the quantum energy, appears to be a complicated function of the magnetization. No such effect was detected when silver targets were used under the latter conditions. (auth)

### 13237

THE NUCLEAR g-FACTOR OF THE 111 keV ROTATIONAL LEVEL AND OTHER ANGULAR CORRELATION MEASUREMENTS ON  $W^{184}$ . E. Bodenstedt, E. Matthias, H. J. Körner, E. Gerdau, F. Frisius, and D. Hovestadt (Physikalisches Staatsinstitut, Hamburg). Nuclear Phys. 15, 239-53(1960) Feb. (2). (In English)

The angular correlations of the 793 keV-111 keV cascade and the 895 keV-111 keV cascade of  $W^{184}$  were measured. The source was prepared as  $KReO_4$  in a liquid solution. It was shown that the coefficients are attenuated by internal fields. The attenuation factors were determined to be,  $G_2 = 0.54$  and  $G_4 = 0.67$ . These angular correlation results confirm the proposed spin values  $I = 2$  for the 904 keV level and  $I = 3$  for the 1006 keV level and identify the 793 keV and the 895 keV transitions as pure E2. A reinvestigation of the half life of the 111 keV state gave,  $T_{1/2} = (1.28 \pm 0.08) \times 10^{-9}$  sec. The half life of the mother isotope  $Re^{184}$  was found to be,  $T_{1/2} = 38 \pm 1d$ , in disagreement with the earlier value of  $50 \pm 2d$ . The nuclear g-factor of the 111

kev rotational level was obtained by determining the rotation of the 793 kev-111 kev angular correlation in an external magnetic field of 36040 gauss. The result,  $g = +0.38 \pm 0.05$ , is in agreement with the prediction of the collective model  $g_R = Z/A$ . (auth)

### 1323H

SPIN OF THE FIRST EXCITED STATE OF  $B^{12}$ . E. Kon-daliah and C. Badrinathan (Tata Inst. of Fundamental Research, Bombay). Nuclear Phys. **15**, 254-60(1960) Feb. (2). (In English)

Angular distribution of gamma rays arising from the 0.95 Mev level of  $B^{12}$  in the reaction  $B^{11}(d,p)B^{12}$  was studied at a deuteron energy of 0.8 Mev. It was found that the gamma angular distribution is definitely non-isotropic and has a minimum at an angle of  $45^\circ$  to the incident deuteron beam. This leads to the exclusion of  $0^+$ ,  $1^-$  and  $2^-$  assignments to the 0.95 Mev level in  $B^{12}$  leaving the possible assignments  $2^+$  or  $3^+$ . (auth)

### 1323P

PROTON CAPTURE BY  $N^{16}$ . D. F. Hebbard (California Inst. of Tech., Pasadena). Nuclear Phys. **15**, 289-315 (1960) Feb. (2). (In English)

The cross section for the reaction  $N^{15}(p,\gamma_0)$  at proton energies below 700 kev was measured. The results fit well an analysis in terms of two interfering  $1^-$  resonances at 338 and 1010 kev (12.43 Mev and 13.09 Mev respectively in  $O^{16*}$ ), with destructive interference in the energy region between the resonances. The  $N^{15}(p,\alpha_0)$  cross section was analyzed using the same parameters, with constructive interference between the resonances, and a good fit to the experimental cross section is obtained. The values of  $S$  obtained by extrapolation to a proton energy of 25 kev (laboratory system) are 32 kev-barn and  $7.2 \times 10^4$  kev-barn respectively for the  $N^{15}(p,\gamma_0)$  and  $N^{15}(p,\alpha_0)$  reactions. The angular distributions of the  $N^{15}(p,\alpha_0)$  reaction were analyzed. The presence of a  $0^+$  resonance near 500-kev proton energy, and a  $2^+$  resonance near 1000-kev proton energy, is indicated. (auth)

### 1324O

THE ANGULAR AND ENERGY DISTRIBUTION OF PROTONS FROM  $Ni^{58}$  REACTIONS INDUCED BY 14.8 Mev NEUTRONS. I. Kumabe and R. W. Fink (Univ. of Arkansas, Fayetteville). Nuclear Phys. **15**, 316-25(1960) Feb. (2). (In English)

The angular and energy distributions of protons from the  $Ni^{58}(n,p)Co^{58}$  and  $Ni^{58}(n,np)Co^{57}$  reactions with 14.8 Mev neutrons were measured using a shielded multiplate camera. The results indicate that the  $Ni^{58}(n,p)$  and  $Ni^{58}(n,np)$  reactions occur predominantly through the formation and decay of the compound nucleus, with a small contribution from the direct interaction of the incident neutrons with protons. A semilog plot of the relative level densities calculated from the energy distribution of the protons fits two straight lines corresponding to Maxwellian distributions with temperatures of about 1.0 Mev for the  $Ni^{58}(n,p)$  reaction and about 0.5 Mev for the  $Ni^{58}(n,p)$  and  $Ni^{58}(n,np)$  reactions. The total cross section determined from this data is  $440 \text{ mb} \pm 10\%$ . (auth)

### 1324I

NEW ISOTOPES OF COBALT; ACTIVATION CROSS-SECTIONS OF NICKEL, COBALT, AND ZINC FOR 14.8 Mev NEUTRONS. I. L. Preiss and R. W. Fink (Univ. of Arkansas, Fayetteville). Nuclear Phys. **15**, 326-36(1960) Feb. (2). (In English)

Absolute neutron activation cross-sections at 14.8 Mev were measured for the five stable nickel isotopes, for co-

balt, and for zinc, based on comparison with the  $Cu^{63}(n,2n)Cu^{62}$  reaction (556 mb), the  $Cu^{65}(n,2n)Cu^{64}$  cross-section (1000 mb), and the  $Al^{27}(n,\alpha)Na^{24}$  reaction (115 mb). During the course of this investigation, three new cobalt activities have been identified as  $Co^{63}$ ,  $1.40 \pm 0.05 \text{ h}$ , and  $Co^{64}$  isomers:  $Co^{64m}$ ,  $2.0 \pm 0.2 \text{ min}$ , and  $Co^{64g}$ ,  $7.8 \pm 0.2 \text{ min}$ . The reactions studied, measured half-lives, and activation cross-sections are listed. Comparison is made between the experimental cross-sections and the continuum model of the compound nucleus described by Blatt and Weisskopf. A discussion is presented concerning the possible reasons for the deviation of the experimental values from those calculated from theoretical considerations. (auth)

### 1324J

NEUTRON STRENGTH FUNCTIONS IN A SURFACE ABSORPTION OPTICAL MODEL. F. C. Khanna and Y. C. Tang (Florida State Univ., Tallahassee). Nuclear Phys. **15**, 337-41(1960) Feb. (2). (In English)

The effect of a surface-peaked imaginary optical potential on the  $S$ -wave neutron strength functions is investigated. Analyses were carried out with both a local potential and a non-local potential of the form used recently by Green and Wyatt in an effort to unify the scattering and bound state problems. The results indicate that with a surface-peaked imaginary potential, the deep valley between the giant resonances ( $90 < A < 130$ ) may be fairly well accounted for. (auth)

### 1324K

ATOMIC MASSES OF NUCLIDES FOR  $A \leq 70$ . F. Everling, L. A. König, and J. H. E. Matthauch (Max-Planck-Institut für Chemie, Mainz) and A. H. Wapstra (Instituut voor Kernfysisch Onderzoek, Amsterdam). Nuclear Phys. **15**, 342-55(1960) Feb. (2). (In English)

Tabulated results are presented for computations of the atomic masses of nuclides for  $A \leq 70$ . Two kinds of data were used for these computations: mass spectroscopic results and nuclear reaction energies (including beta decay energies). (B.O.G.)

### 1324L

THE SCATTERING OF 38 MEV ALPHA PARTICLES BY  $C^{12}$ . I. J. Van Heerden (National Physical Research Lab., C.S.I.R., Pretoria) and D. J. Prowse (Univ. of California, Los Angeles). Nuclear Phys. **15**, 356-62(1960) Feb. (2). (In English)

The differential cross sections for the elastic and inelastic scattering of 38 Mev alpha particles from  $C^{12}$  were measured using a photographic technique. Comparisons with the work of other authors at slightly different energies indicate that the angular distributions vary rather strongly with beam energy. The variation of the elastic distribution is too great to be explained on the basis of the simple optical model. (auth)

### 1324M

EXCITATION OF THE NUCLEAR GIANT-DIPOLE RESONANCE BY INELASTIC ELECTRON SCATTERING. S. Fallieros, R. A. Ferrell, and M. K. Pal (Univ. of Maryland, College Park). Nuclear Phys. **15**, 363-72(1960) Feb. (2). (In English)

The Goldhaber-Teller model of the giant dipole resonance of a nucleus was cast in the language of the shell-collective model by using the generator coordinate method of Hill, Wheeler, and Griffin. The wave function for the excited state found in this way was used to evaluate explicitly the inelastic electron scattering form factor for excitation of the giant dipole resonance of the nucleus.



The form factor is found to be proportional to the elastic form factor multiplied by the momentum transfer. From an estimate of the bremsstrahlung background extracted from Fregeaus's data it is concluded that experimental investigation of the giant dipole resonance by electron scattering is feasible at optimum momentum transfer. (auth)

### 13246

CROSS SECTION AND ASYMMETRY IN THE DEUTERON PICKUP REACTION  $C^{12}(p,d)C^{11}$  AT 145 Mev. Paul F. Cooper, Jr. and Richard Wilson (Harvard Univ., Cambridge, Mass.). Nuclear Phys. **15**, 373-86(1960) Feb. (2). (In English)

A carbon target was bombarded with polarized protons of average energy 145 Mev and cross sections and asymmetries were measured for deuterons emerging at angles between  $5^\circ$  and  $40^\circ$  to the incident beam. The asymmetry is small at angles less than  $15^\circ$ , but rises rapidly to become nearly 100% at  $40^\circ$ . The results for the cross sections are in agreement with recent calculations including multiple scattering corrections to the impulse approximation. They show that multiple scattering effects dominate at large angles and prevent a search for high momentum components by this method. (auth)

### 13247

SYMPLECTIC SYMMETRY IN THE NUCLEAR SHELL MODEL. J. B. French (Univ. of Rochester, N. Y. and Rijksuniversiteit, Utrecht). Nuclear Phys. **15**, 393-410 (1960) Mar. (1). (In English)

The nature of the general two-particle interaction which is compatible with symplectic symmetry in the  $jj$  coupling shell model is investigated. The essential result is that, to within an additive constant and an additive multiple of  $T^2$ , the interaction should have the form of a sum of scalar products of single-particle tensors which have odd rank in the single-particle  $j$  space. An example of an interaction satisfying these conditions is a central interaction with  $\sigma_1 \cdot \sigma_2$  exchange nature. The condition for good symplectic symmetry is expressed also as a set of linear constraints on the two-particle energies, again as constraints on the particle-hole energies and finally in terms of the relationship between the particle-particle and particle-hole spectra. When we deal with identical particles only, the conditions for good symplectic symmetry (or seniority) are greatly relaxed and in particular are satisfied for a short-range ( $\delta$ -function) interaction, as shown earlier by Racah and Talmi. (auth)

### 13248

PROTON CAPTURE IN  $Be^7$ . Ralph W. Kavanagh (California Inst. of Tech., Pasadena). Nuclear Phys. **15**, 411-20 (1960) Mar. (1). (In English)

Cross sections for proton capture by  $Be^7$  measured at bombarding energies of 800 kev and 1400 kev are  $0.48 \pm 0.18$  and  $0.50 \pm 0.20 \mu b$ , respectively, from which the corresponding cross section factors are  $S = 0.027 \pm 0.010$  and  $0.017 \pm 0.007 \text{ kev} \cdot b$ . The reaction is important in stellar energy production only in stars operating on the proton-proton chain at temperatures greater than about  $2 \times 10^7 K$ . (auth)

### 13249

SMALL ANGLE SCATTERING OF ELECTRONS. I. Berkes and I. Demeter (Central Research Inst. for Physics, Budapest). Nuclear Phys. **15**, 421-35(1960) Mar. (1). (In English)

The small angle scattering of 615 kev electrons was studied on N, Ar, Kr, and Xe gases. It was found that if

the electron cloud of atoms is considered in Hartree representation, for angles  $\theta < 1.5 \times 10^{-3}$  radians, covered by the measurements, the differential cross sections for elastic and inelastic scattering are in agreement with the theory. The screening of elastic scattering being represented by an exponential factor  $e^{-x/a}$ , the screening parameters  $a = (1.23 \pm 0.067)a_0 Z^{-1/2}$  and  $a = (1.195 \pm 0.070) \times a_0 Z^{-1/2} [Z/(Z-1)]^{1/2}$ , respectively, give the best representation of the experimental results. (auth)

### 13250

$(\gamma, d^{np})$  REACTIONS IN  $S^{32}$ ,  $Ca^{40}$ ,  $Ge^{70}$ . F. Ferrero, S. Ferroni, R. Malvano, S. Menardi, and E. Silva (Università, Turin, and Istituto Nazionale di Fisica Nucleare, Turin). Nuclear Phys. **15**, 436-51(1960) Mar. (1). (In English)

A detailed study, up to 31 Mev, of the  $(\gamma, np)$  and  $\gamma, d$  reactions in  $S^{32}$ ,  $Ca^{40}$ , and  $Ge^{70}$  has been carried out, together with the study of the other processes:  $(\gamma, n)$ ,  $(\gamma, Tn)$   $(\gamma, Tn)_{E_{\gamma} \geq 5.5 \text{ Mev}}$ . A rather flat cross section is found for the  $(\gamma, d^{np})$  reaction, peaking presumably above 31 Mev. In the cases of S and Ca it was found that the neutron spectrum associated with the above reaction is much more energetic than could be explained on the basis of a simple evaporation process. A discussion is given of the possible explanation of the above experimental evidence on the basis of some direct photonuclear process. (auth)

### 13251

ANGULAR DISTRIBUTION OF PROTONS FROM  $Li^6(d, p)Li^7$  AND  $Li^6(d, p)Li^{7*}$ . G. O. André (Norwegian Inst. of Tech., Trondheim, Norway). Nuclear Phys. **15**, 464-8(1960) Mar. (1). (In English)

The angular distribution of protons from  $Li^6(d, p)Li^7$  and  $Li^6(d, p)Li^{7*}$  has been measured, and the intermediate coupling parameter is calculated. (auth)

### 13252

INELASTIC SCATTERING OF NUCLEONS BY ASYMMETRICALLY DEFORMED NUCLEI. A COMMENT ON THE STRUCTURE OF MEDIUM WEIGHT NUCLEI. Haruo Ui (Tokyo Univ.). Nuclear Phys. **15**, 495-500(1960) Mar. (1). (In English)

The inelastic scattering of nucleons by direct excitation of nuclear rotational states is investigated, in which the target nucleus is described by an asymmetric top wave function as recently proposed by Davydov and Filippov. Then, in even nuclei, not only the first rotation state, but also another  $2^+$  rotation state can be excited by the first-order direct interaction. The cross sections to these two states are presented as functions of the deformation parameters  $\beta$  and  $\gamma$  of A. Bohr. Brief discussions are added in connection with the vibration model. It is pointed out that the measurement of these cross sections and angular correlations between emitted nucleons and  $\gamma$ -rays would provide means for determining the structure of medium weight nuclei. (auth)

### 13253

ON THE K-CONVERSION COEFFICIENT OF THE 279 kev GAMMA RAY IN THE DECAY OF  $Hg^{203}$ . M. K. Ramaswamy and P. S. Jastram (Ohio State Univ., Columbus). Nuclear Phys. **15**, 510-12(1960) Mar. (1). (In English)

The K-conversion coefficient of the 279 kev gamma-ray following the beta-decay of  $Hg^{203}$  has been measured by comparing the x-ray and gamma-ray intensities in a scintillation spectrometer. The measured value of  $\alpha_K = 0.195 \pm 0.014$  indicates that the transition is M1 with E2 mixed to the extent of 63%. Our value is considerably higher than the magnetic beta spectrometer determinations, but is in

agreement with the results of Johansson using the scintillation method. (auth)

### 13254

#### NOTE ON SYMMETRY OF STRONG INTERACTIONS.

L. Łukaszyk (Univ. of Warsaw). *Nuclear Phys.* **15**, 513-15(1960) Mar. (1). (In English)

A form of strong interaction is discussed in the frame of the theory of elementary particles given by W. Kröllkowski. Interaction Hamiltonians are set up which tentatively explain the binding energies of hyperfragments and the baryon mass spectrum. (B.O.G.)

### 13255

#### AN UNUSUAL DOUBLE STAR FROM A $K^-$ -CAPTURE IN EMULSION.

M. Nikolić, W. Koch, M. Schneeberger, and H. Winzeler (Universität, Bern). *Nuclear Phys.* **15**, 519-21 (1960) Mar. (1). (In English)

During a study of double stars produced by  $K^-$  interactions in flight and at rest, a  $K^-$  meson came to rest and produced a 3 prong star. One track belongs to a 62-Mev  $\pi^+$  meson, the other two tracks have lengths of  $6\mu$  and  $14\mu$ . At the end of the  $6\mu$  track, a  $\pi^-$  is emitted of total range  $9417\mu$  and energy 22.2 Mev. The  $\pi^-$  meson undergoes an elastic deflection of  $49^\circ$ ,  $3612\mu$  before coming to rest. (B.O.G.)

### 13256

#### NUCLEAR SHAPE EFFECT ON ISOMERIC SHIFT.

J. Lardinois (Université Libre, Brussels). *Nuclear Phys.* **15**, 522-4(1960) Mar. (1). (In English)

The nuclear isomeric shift for  $\text{In}^{115}$  III (odd-proton nucleus) and  $\text{Hg}^{197}$  (odd-neutron nucleus) was calculated taking account of a collective deformation of the core. Theoretical results agree with experimental data for  $\text{Hg}^{197}$ . (auth)

### 13257

#### THE HALF LIFE OF $\text{In}^{116}$ .

A. Ducat and R. H. Thomas (Associated Electrical Industries, Aldermaston, Berks, Eng.). *Nuclear Phys.* **15**, 525-6(1960) Mar. (1). (In English)

Six independent measurements were made and the  $\text{In}^{116}$  half life was calculated by the method of least squares to give a weighted mean of  $14.05 \pm 0.26$  s. The error quoted includes a possible error of  $\pm 0.10$  s from the dead-time correction uncertainty. (B.O.G.)

### 13258

#### 0+ LEVELS OF EVEN NUCLEI IN THE RARE-EARTH REGION.

Ingvar Marklund, Bob van Nooljen, and Zbigniew Grabowski (Inst. of Physics, Uppsala). *Nuclear Phys.* **15**, 533-65(1960) Mar. (2). (In English)

The beta type quadrupole vibrations of deformed nuclei have been found in only a few cases in the heavy element region. A search was started in order to find such levels in the rare-earth region. A 0+ beta type level at 685.0 kev was found in the deformed nucleus  $\text{Sm}^{152}$  by measuring conversion coefficients. Its corresponding 0+ two-phonon type level was observed in  $\text{Gd}^{152}$  at 615.3 kev. The strongly deformed nucleus  $\text{Er}^{166}$  has a 0+ level at 1460.4 kev now confirmed by angular correlation measurements. The 1087 kev level in  $\text{Os}^{188}$  and the 1267 kev level in the spherical nucleus  $\text{Pt}^{194}$  were measured by angular correlation to have zero spins, indicating the same trend of the 0+ levels as theoretically expected. (A second excited 0+ level was found in  $\text{Os}^{188}$  at 1766 kev and in  $\text{Pt}^{194}$  at 1480 kev.) When the beta and gamma vibrational bands are known, the theoretical and experimental rotational-vibrational coefficients can be compared:  $B^{\text{theory}} = kB^{\text{exp}}$ . A k-value of 2 to 4 is found, indicating a weaker coupling than that theoretically expected. The experimental trend

of levels in even nuclei with  $A = 50$  to 250 is discussed, and some new spin assignments are proposed. (auth)

### 13259

THE DECAY OF  $\text{Au}^{194}$ . G. Bäckström, O. Bergman, J. Burde, and J. Lindskog (Inst. of Physics, Uppsala). *Nuclear Phys.* **15**, 566-608(1960) Mar. (2). (In English)

The decay of  $\text{Au}^{194}$  was investigated by the use of high resolution spectrometers for the measurements of the conversion spectrum and a double lens spectrometer for coincidence measurements. By careful analysis of the conversion spectrum, which was recorded at a resolution of  $\approx 0.2\%$ , it was possible to identify more than 100 transitions in  $\text{Pt}^{194}$ . The use of strong sources and a double counter operated in coincidence made possible the detection of lines of intensity only  $10^{-5}$  times that of the strongest line. Multipolarities could be found from K/L ratios for a few low energy transitions and some information could be extracted from a comparison with results of previous gamma ray work. Energies of the strongest lines were measured absolutely by means of an iron free double focusing instrument, and further energy determinations were made relatively to these lines. The standard error of the measurements was frequently as low as 2 parts in  $10^4$ . A complete set of energy sums was computed in order to survey the possibilities of cascade-crossover combinations. The reliability of the numerical relationships was investigated statistically, and it was shown that a reasonably unique level scheme could be constructed on the basis of energies, although the positions of transitions remained to some extent ambiguous. The results of 79 coincidence experiments are reported, and when analyzed these data lead to a level scheme in agreement with the conclusions of the other approach. These experiments helped in deciding the location of transitions. Evidence for at least two  $0^+$  states was found. The discovery of a level at 923 kev, probably of  $4^+$  character, revealed a close analogy with the level scheme of  $\text{Pt}^{192}$ . The interpretation of this level as a three-phonon state is in agreement with theory. (auth)

### 13260

#### ALPHA SPECTRA FROM THE DECAYS OF $\text{Li}^8$ AND $\text{B}^8$ .

B. J. Farmer and C. M. Class (Rice Inst., Houston, Tex.). *Nuclear Phys.* **15**, 626-35(1960) Mar. (2). (In English)

The spectra of alpha particles accompanying the dissociation of  $\text{Be}^8$ , following the beta decays of  $\text{Li}^8$  and  $\text{B}^8$ , were measured. The spectra were found to be essentially identical, confirming the expected symmetry in the decay schemes of  $\text{Li}^8$  and  $\text{B}^8$ . The spectrum associated with the decay of  $\text{Li}^8$  was compared with that given by the modified single level of Wheeler. The spectrum is not adequately accounted for by this formula if current values of the parameters are used to describe the  $2^+$  and  $4^+$  levels at 2.9 and 11.7 Mev in  $\text{Be}^8$  which are assumed to be participating. An alternative description of the alpha spectrum, involving only the  $2^+$  levels in  $\text{Be}^8$  at 2.9 and 16.7 Mev, was given recently by Biedenharn and Griffy. Their expressions are found to be in agreement with the data over an energy range of more than 10 Mev, and hence may be taken as the preferred description of the process. (auth)

### 13261

#### BETA DECAY INVOLVING THE $\text{Be}^8(2^+)$ STATE.

T. A. Griffy and L. C. Biedenharn (Rice Inst., Houston, Tex.). *Nuclear Phys.* **15**, 636-45(1960) Mar. (2). (In English)

The shape of the alpha and beta spectra in the  $\text{Li}^8(\beta^-, \alpha)\alpha$  and  $\text{B}^8(\beta^+, \alpha)\alpha$  decay is calculated directly from alpha-alpha scattering phase shifts and the assumption that the decays



involve only  $\text{Be}^8$  in a ( $2^+$ ) intermediate state. Recent experimental results are in good agreement with the calculated spectra. (auth)

### 13262

GAMMA RAYS FOLLOWING THE DECAY OF  $\text{Nd}^{147}$  AND  $\text{Sm}^{153}$ . T. J. Walters, J. H. Webber, N. C. Rasmussen, and Hans Mark (Massachusetts Inst. of Tech., Cambridge). *Nuclear Phys.* **15**, 653-6(1960) Mar. (2). (In English)

A two meter radius bent quartz crystal spectrograph was used to study gamma rays following the  $\beta^-$ -decay of  $\text{Nd}^{147}$  and  $\text{Sm}^{153}$ . A gamma ray of  $91.05 \pm 0.04$  kev was observed following the decay of  $\text{Nd}^{147}$ . This gamma ray corresponds to the transition between the first excited level and the ground state of the isotope  $\text{Pm}^{147}$ . Three gamma rays are observed in the decay of  $\text{Sm}^{153}$ . Two strong lines at  $103.17 \pm 0.04$  kev and  $69.66 \pm 0.02$  kev correspond to short-lived isomeric levels in  $\text{Eu}^{153}$ . These have been observed previously. In addition, a weak line at  $97.42 \pm 0.04$  kev is present. A line at approximately this energy was observed in the electron capture decay of  $\text{Gd}^{153}$  to  $\text{Eu}^{153}$ . The intensity ratio of the 103.17 kev transition to the 97.42 kev line is greater than 20 to 1. (auth)

### 13263

PROTACTINIUM-237. K. Takahashi and H. Morinaga (Tōkoku Univ., Sendai). *Nuclear Phys.* **15**, 664-77(1960) Mar. (2). (In English)

Protactinium-237 was produced from the reaction  $\text{U}^{238}(\gamma, p)\text{Pa}^{237}$  by 25-Mev bremsstrahlung. The activity produced was chemically separated. The half-life was found to be  $T_{1/2} = 39 \pm 3$  min. The radiations were measured with a scintillation spectrometer. Three beta components were identified with the end-points  $2.30 \pm 0.05$  Mev, 1.35 Mev, and about 0.8 Mev. Many gamma rays were found. A decay scheme was constructed with the aid of Nilsson's unified model. (auth)

### 13264

THE INELASTIC SCATTERING OF DEUTERONS FROM  $^{12}\text{C}$ . W. M. Fairbairn (The College of Science and Tech., Manchester, Eng.). *Nuclear Phys.* **15**, 678-82(1960) Mar. (2). (In English)

The angular distribution of deuterons scattered inelastically from  $\text{C}^{12}$  is determined using a direct interaction theory which assumes the excitation of a single one-particle level in the intermediate state. Comparison is made with the experimental data for two bombarding energies. The agreement is good and the method could be extended to other nuclei to obtain information about nuclear structure. (auth)

### 13265

THE CIRCULAR POLARIZATION OF THE GAMMA RAYS FOLLOWING THE  $\beta$  DECAY OF  $\text{Fe}^{59}$ . H. H. Forster and N. L. Sanders (Univ. of Southern California, Los Angeles). *Nuclear Phys.* **15**, 683-6(1960) Mar. (2). (In English)

The circular polarization of the gamma rays emitted in the beta decay of  $\text{Fe}^{59}$  was measured using the method of forward scattering from a magnetized Armco iron cylinder. A method is described to separate the effects due to the two dominant decay modes. For the 461 kev  $\beta$ -1.099 Mev  $\gamma$  cascade an asymmetry coefficient  $A = -0.46 \pm 0.08$  was determined; for the 271 kev  $\beta$ -1.20 Mev  $\gamma$  transition the asymmetry coefficient was  $A = -0.04 \pm 0.11$ . (auth)

### 13266

THE ELASTIC SCATTERING OF  $^3\text{He}$  BY MEDIUM WEIGHT NUCLEI. G. W. Greenlees and P. C. Rowe (Univ. of

Birmingham, Eng.). *Nuclear Phys.* **15**, 687-93(1960) Mar. (2). (In English)

Absolute differential cross-sections were measured for the elastic scattering of  $\text{He}^3$  from Ni, Pd, Cd, Sn, and Au. Energy distributions for Ni, Cd, and Au in the region 30 to 18 Mev and angular distributions for Ni, Pd, Cd, and Sn in the range  $15$  to  $60^\circ$  (C.M.) were found. The results show that an approximately exponential fall-off in cross-section occurs in both the energy and angular variations. Interaction radii were derived from the experimental curves by using the sharp cut-off theory of Blair. By comparison with recent alpha-particle results the difference in the  $\text{He}^3$  and  $\text{He}^4$  interaction radii was found to be  $(0.11 \pm 0.01) \times 10^{-13}$  cm. (auth)

### 13267

THE NUCLEAR COMPRESSIBILITY FROM ISOTOPE SHIFT DATA. N. J. Ionesco-Pallas (Rumanian Inst. for Atomic Research, Bucharest). *Nuovo cimento* (10) **15**, 323-33(1960) Feb. 1. (In English)

A general theory of isotope shift in heavy atoms taking into account the nuclear specific effects as well as those due to electronic shells is given. The shift problem is resolved rigorously under the assumption that the proton distribution in nuclei is that of Fermi. For the computation of compressibility the model of Wilets with some modification is used. The wide range of mass numbers, including the high nuclear deformation region, leads to the need of Johnson-Teller effect and to a value for compressibility of about 77 Mev, which is in agreement with some theoretical expectations. (auth)

### 13268

L AND M CONVERSION RATIOS IN  $\text{Os}^{192}$  AND  $\text{Pt}^{192}$ . L. Marinkov, M. Mladjenović, R. Stepić, and M. Župančić (Boris Kidrič Inst. for Nuclear Sci., Belgrade). *Nuovo cimento* (10) **15**, 496-7(1960) Feb. 1. (In English)

The internal conversion spectra of  $\text{Pt}^{192}$  and  $\text{Os}^{192}$  were measured, and the ratios are given for the L and M lines. The agreement between the ratios and those deduced from theory is excellent. Where the L lines were clear and separable, they agreed well with theoretical values. Ratios for mixed transitions gave the same percentage of M-1 admixture, thus indicating that precise measurements of L ratios can give reliable information on mixtures. (D.L.C.)

### 13269

NOTE ON THE EFFECT OF THE NUCLEAR ENERGY GAP ON THE OPTICAL MODEL POTENTIAL. J. Sawicki (Univ. of California, Berkeley). *Nuovo cimento* (10) **15**, 504-7(1960) Feb. 1. (In English)

The effect of the energy gap on the optical model potential was calculated by combining Migdal's Green-type derivation with Watson's expression for the potential. It was found to be negligible in the case of nuclear matter. (D.L.C.)

### 13270

BREMSSTRAHLUNG LINEAR POLARIZATION. J. W. Motz and R. C. Placious (National Bureau of Standards, Washington, D. C.). *Nuovo cimento* (10) **15**, 571-98(1960) Feb. 16. (In English)

A general quantitative description is given of the bremsstrahlung linear polarization on the basis of experimental data and theoretical calculations. The results give the dependence of the polarization on: the initial electron kinetic energy at  $10^{-2}$  to  $10^3$  Mev; the photon energy from  $0.1 T_0$  to  $T_0$ ; the photon emission angle at  $0$  to  $180$  degrees, and the atomic number of the target from

4 to 79. The experimental data were obtained for electron energies of 0.05 to 1.0 Mev with beryllium, aluminum, and gold targets. Theoretical estimates of the polarization were calculated from the Sommerfeld-Kirckpatrick-Wiedmann results for the non-relativistic energy region, the Olson-Maximon results for the extreme relativistic energy region, and the Gluckstern-Hull (Born approximation) results for the intermediate energy region. Results are expressed in terms of the peak polarization and the corresponding peak angle as a function of the electron and photon energies. Best estimates of the polarization are given on the basis of the combined experimental and theoretical data. (auth)

### 13271

NOTE ON THE TARGET EXCHANGE CORRECTIONS IN WATSON'S THEORY OF THE OPTICAL MODEL POTENTIAL. J. Sawicki (Univ. of California, Berkeley). Nuovo cimento (10) 15, 606-13(1960) Feb. 16. (In English)

The generalization of Watson's theory of the optical model potential to the case of completely antisymmetrized wave functions of the  $A + 1$  particles system given by Rollnik is discussed. The lowest order corrections to the nuclear potential in the Takeda and Watson formulation being of the target exchange type are estimated for several energies of the scattering nucleon. (auth)

### 13272

AN EXPERIMENTAL TEST OF PARITY CONSERVATION IN  $\pi^0$ -MESON PRODUCTION BY NEUTRONS. D. G. Davis, R. C. Hanna, F. F. Heymann, and C. Whitehead (European Organization for Nuclear Research, Geneva). Nuovo cimento (10) 15, 641-51(1960) Feb. 16. (In English)

A carbon target was bombarded with a beam of transversely polarized neutrons of energy up to 540 Mev.  $\pi^0$ -mesons ejected at right angles to the neutron beam were detected through their decay  $\gamma$ -rays in energy-sensitive Cherenkov counters. A fore-aft asymmetry in  $\pi^0$  production relative to the polarization vector of the neutron beam was sought which would have been indicative of a parity violating term of the form  $\sigma_n \cdot k_\pi k_p$ . A reversible longitudinal magnetic field was used to precess the neutron beam polarization vector to enable the asymmetries to be measured with minimal systematic errors. The experiment was sensitive to asymmetries of 1 in  $10^3$ . Values of  $P$ , the parity violating polarization in the reaction, of  $-0.005 \pm 0.020$  to  $-0.079 \pm 0.050$  were found for  $\pi^0$ 's of various energies. (auth)

### 13273

EFFECT OF NUCLEAR MAGNETIC MOMENT ON THE BREMSSTRAHLUNG OF ELECTRONS. Sasabindu Sarkar (Indian Assn. for the Cultivation of Science, Calcutta). Nuovo cimento (10) 15, 686-90(1960) Feb. 16. (In English)

Electron-nucleus bremsstrahlung is treated by representing the nucleus as a static model having charge and magnetic moment, the electromagnetic potentials of which were given by Newton. The cross-section is derived for the case of targets with definite direction of the magnetic moment of the nuclei and then averaged over all such possible directions. (auth)

### 13274

CALCULATIONS OF TOTAL CROSS SECTIONS FOR SCATTERING FROM COULOMB POTENTIALS WITH EXPONENTIAL SCREENING. G. H. Lane and E. Everhart (Univ. of Connecticut, Storrs). Phys. Rev. 117, 920-24(1960) Feb. 15.

Momentum transfer cross sections and total cross sections are calculated for scattering from the potential en-

ergy function  $V = (Z_1 Z_2 e^2 / r) \exp(-r/a)$ . The cross sections are obtained by integrating the differential cross section over all angles using a classical calculation or a Born approximation calculation. The validity criteria are discussed as they depend on the de Broglie wavelength of the scattered particle. In certain cases the Born approximation solution is valid at small angles and the classical solution is valid at large angles. Graphs and tables are presented showing the results as functions of suitable parameters. The momentum transfer cross section is finite in all cases and the total cross section is finite except in the classical limit. In this limit, however, calculations are presented showing that portion of the total cross section which arises from scattering through angles greater than a specified small angle. (auth)

### 13275

NUCLEAR LEVELS OF  $\text{Cs}^{133}$ . M. G. Stewart and D. C. Lu (Iowa State Univ. of Science and Tech., Ames). Phys. Rev. 117, 1044-51(1960) Feb. 15.

The gamma rays of  $\text{Cs}^{133}$  following the electron-capture decay of  $\text{Ba}^{133}$  were studied using a coincidence scintillation spectrometer. Gamma rays with the following energies were observed: 386, 356, 301, 276, (220), 162, 82, 80, and 54 keV. The energies of the nuclear levels of  $\text{Cs}^{133}$  with their spins and parities are: ground state ( $1/2^+$ ), 82 ( $5/2^+$ ), 162 ( $3/2^+$ ), 383 ( $3/2^+$ ), and 438 ( $1/2^+$ ) keV. The electron-capture transitions and their relative intensities are as follows: (a) to the 438-keV level, 76% (b) to the 383-keV level, 11% (c) to the 162-keV level, 13%. In the decay of  $\text{Xe}^{133}$ ,  $1.5 \pm 1.0\%$  of the beta transitions was observed to go to the 162-keV level in  $\text{Cs}^{133}$  and the remaining go to the 82-keV level. (auth)

### 13276

INFLUENCE OF 1-FORBIDDENNESS ON THE 82-KEV TRANSITION IN  $\text{Cs}^{133}$ . F. M. Clikeman and M. G. Stewart (Iowa State Univ. of Science and Tech., Ames). Phys. Rev. 117, 1052-5(1960) Feb. 15.

The gamma-gamma directional correlation of the 356 to 82-keV cascade in  $\text{Cs}^{133}$  was measured. The directional correlation coefficients were  $A_2/A_0 = 0.031 \pm 0.006$  and  $A_4/A_0 = -0.006 \pm 0.010$ . This is consistent with a spin assignment  $1/2(Q) 5/2(D + Q) 1/2$ . The ratio of the E2 to M1 matrix elements for the 82-keV transition is  $\delta = -0.139 \pm 0.007$ . The M1 transition is retarded by a factor of  $\sim 700$  and the E2 transition is enhanced by a factor of  $\sim 20$ , compared to single particle transitions. The retardation of the M1 transition is consistent with the assignment  $d_{5/2}^2$  for the 82-keV state and  $g_{1/2}^2$  for the ground state which would make the M1 transition 1 forbidden. The enhancement of the E2 transition indicates there is a cooperative phenomenon present. (auth)

### 13277

TOTAL NEUTRON CROSS SECTION FOR  $\text{C}^{12}$  FROM 500 KEV TO 1350 KEV. C. M. Huddleston, R. O. Lane, L. L. Lee, Jr., and F. P. Mooring (Argonne National Lab., Lemont, Ill.). Phys. Rev. 117, 1055-6(1960) Feb. 15.

The total neutron cross section of  $\text{C}^{12}$  was measured in an effort to observe resonances corresponding to states recently reported in the  $\text{B}^{11}(\text{He}^3, p)\text{C}^{13}$  reactions. No resonances were observed within the 5% accuracy of the measurement. Upper limits are set on the possible widths of the states. (auth)

### 13278

DYNAMIC ORIENTATION OF NUCLEI BY FORBIDDEN TRANSITIONS IN PARAMAGNETIC RESONANCE. C. D.



Jeffries (Univ. of California, Berkeley). *Phys. Rev.* **117**, 1056-69(1960) Feb. 15.

Principally from the viewpoint of orienting radionuclei, this paper considers magnetically dilute paramagnetic ions in crystals for various cases in which there is a non-negligible radio-frequency transition probability for inducing a simultaneous flipping of an electron spin and a nuclear spin. These transitions, forbidden in zero order in high magnetic fields, may be provided by hyperfine interactions, and allow for direct dynamic nuclear orientation by applied r-f fields. The transition probabilities are calculated for a general anisotropic spin hamiltonian; thermal relaxation transitions are qualitatively discussed. The resulting steady-state dynamic nuclear polarization and alignment are calculated for the equalization of populations of pairs of levels by sufficient applied r-f fields. The influence of various relaxation transitions is considered and it is noted that the nuclear orientation available through the forbidden transitions is considerably less sensitive to competing relaxation transitions than that obtained by saturation of the allowed transitions. The general predictions are found to be in qualitative agreement with the results at Berkeley of Abraham and Kedzie using radio-nuclei. The possibilities for dynamic alignment of radio-nuclei of diamagnetic atoms by forbidden transitions due to weak nuclear-electron dipolar coupling are also briefly discussed. (auth)

### 13279

DYNAMIC NUCLEAR ORIENTATION OF  $\text{Co}^{60}$ . M. Abraham, C. D. Jeffries, and R. W. Kedzie (Univ. of California, Berkeley). *Phys. Rev.* **117**, 1070-74(1960) Feb. 15.

An experiment to dynamically orient  $\text{Co}^{60}$  nuclei is described, using a method discussed in the preceding paper; the orientation is detected by the  $\gamma$ -ray anisotropy. The  $\text{Co}^{60}$  is contained as  $\text{Co}^{2+}$  ions in magnetically isotropic sites of a single crystal of  $\text{La}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{D}_2\text{O}$  at 1.5°K and in a field of  $\sim 1500$  gauss. Application of a r-f field at a frequency  $\nu \sim 9400$  Mc/sec produces an orientation when the forbidden hfs transitions  $W_2(M, m \rightarrow M \pm 1, m \mp 1)$  are induced;  $m$  and  $M$  are the magnetic quantum numbers of the  $\text{Co}^{60}$  nucleus and the  $\text{Co}^{2+}$  ion, respectively. With a few milliwatts of microwave cavity power a steady-state dynamic nuclear orientation is reached in a time less than a few seconds yielding an anisotropy  $\epsilon \sim 1\%$ , smaller by a factor 2.7 than the theoretical optimum value. No  $\gamma$ -ray anisotropy is observed when the allowed hfs transitions  $W_1(M, m \rightarrow M \pm 1, m)$  are induced. Also, no  $\gamma$ -ray anisotropy is found upon inducing either  $W_1$  or  $W_2$  for  $\text{Co}^{2+}$  located in the magnetically anisotropic sites in the crystal. All the above observations are in agreement with the theoretical expectations. An anomalous orientation of  $\text{Co}^{60}$  is observed when the allowed hfs transitions of abundant stable  $\text{Co}^{59}$  in the same crystal are strongly induced. This is explicable in terms of a mutual spin-flip process between the two systems. (auth)

### 13280

RADIATION FROM  $\text{Ga}^{64}$ . Thomas H. Jacobl and J. Reginald Richardson (Univ. of California, Los Angeles) and H. A. Howe (U. S. Naval Radiological Defense Lab., San Francisco). *Phys. Rev.* **117**, 1086-90(1960) Feb. 15.

The  $\beta^+$  decay of  $\text{Ga}^{64}$  and the subsequent gamma spectrum from the de-excitation of  $\text{Zn}^{64}$  were studied. The  $\beta^+$  transition to the ground state of  $\text{Zn}^{64}$  has an end point energy of  $6.05 \pm 0.03$  Mev with  $\log ft = 6.6$  and another  $\beta^+$  group or groups has an end point energy of  $2.79 \pm 0.08$  Mev with a  $\log ft = 4.6$ . No  $\beta^+$  transition to the first excited state of  $\text{Zn}(2+)$  was observed and it was shown that the  $\log$

$ft$  corresponding to this transition is greater than 7.7. The gamma rays that were observed (0.80, 0.99, 1.25, 1.38, 1.56, 1.78, 1.95, 2.18, 2.34, 2.99, and 3.32 Mev) indicate excited states at 0.99(2+), 1.78(2+), and 3.32(1+) Mev. The positron results indicate that the ground state of  $\text{Ga}^{64}$  has spin and parity  $0^+$ . (auth)

### 13281

POLARIZATION OF ELECTRONS IN BETA DECAY OF THALLIUM-204. D. Beaglehole (Univ. of Wellington, N. Z.). *Phys. Rev.* **117**, 1091(1960) Feb. 15.

The longitudinal polarization of electrons from the beta decay of thallium-204 was measured by the Möller scattering method. The asymmetry was measured to be  $0.08 \pm 0.06$ , corresponding to a longitudinal polarization of  $-1.15 \pm 0.87$ . (auth)

### 13282

BETA-GAMMA DIRECTIONAL CORRELATION IN THE DECAY OF  $\text{Eu}^{152}$ . Harry Dulaney, Jr., C. H. Braden, and L. D. Wyly (Georgia Inst. of Tech., Atlanta). *Phys. Rev.* **117**, 1092-4(1960) Feb. 15.

The directional correlation between the 1459-kev beta group and the 345-kev gamma ray of  $\text{Eu}^{152}$  was measured as a function of beta energy at energies above 800 kev. The results show good agreement with the theoretical correlation for a first forbidden beta transition with  $\Delta J = 1$ . The influence of the relative size of the matrix elements on the shape of the beta spectrum is discussed. (auth)

### 13283

ELECTRON CAPTURE DECAY OF  $\text{Tm}^{168}$  AND  $\text{Tm}^{166}$ . K. P. Jacob and J. W. Mihelich (Univ. of Notre Dame, Ind.) and B. Harmatz and T. H. Handley (Oak Ridge National Lab., Tenn.). *Phys. Rev.* **117**, 1102-11(1960) Feb. 15.

The electron capture of  $\text{Tm}^{168}$  (87 day) to levels in  $\text{Er}^{168}$  was investigated with permanent magnet spectrographs and coincidence scintillation spectrometers. The following levels in  $\text{Er}^{168}$  were established: 79.8(2+), 264.3(4+), 548.9(6+), 822.4(2+), 897.0(3+), 996.2(4+), 1095.1(3- and  $T_{1/2} = 1.2 \times 10^{-7}$  sec), and 1543.1(3-) kev. The internal conversion data for  $\text{Tm}^{168}$  (7.7 hour) suggest levels in  $\text{Er}^{168}$  at 80.6(2+), 265.1(4+), 545.3(6+), 787.1(2+), 860.6(3+), and 957.2(4+) kev with many more high lying levels. Energy level schemes are proposed for both  $\text{Er}^{168}$  and  $\text{Er}^{166}$ . The levels at 822, 897, and 996 kev in  $\text{Er}^{168}$  and 787, 861, and 957 kev in  $\text{Er}^{166}$  may possibly be associated with electric quadrupole (gamma) vibrations. Some general features regarding these vibrational levels are discussed and compared with available data on other even-even nuclei in the rare earth region. (auth)

### 13284

$\text{Cu}^{65}(\gamma, 3n)$  REACTION AND ITS BEARING ON THE USE OF THE  $\text{Cu}^{63}(\gamma, n)\text{Cu}^{62}$  REACTION FOR BREMSSTRAHLUNG MONITORING. M. J. Aitken and N. Middlemas (Clarendon Lab., Oxford). *Phys. Rev.* **117**, 1111-12(1960) Feb. 15.

The  $\text{Cu}^{65}(\gamma, 3n)$  reaction was measured from threshold to 110 Mev. The integrated cross section at 110 Mev is  $0.037 \pm 0.004$  Mev barn. The consequent error in bremsstrahlung monitoring through ignoring this contribution varies from 0.9% at 40 Mev to 1.4% at 110 Mev. (auth)

### 13285

NUCLEAR RESONANCE FLUORESCENCE IN  $\text{Au}^{197}$ . D. Nagle, P. P. Craig, J. G. Dash, and R. R. Reiswig (Los Alamos Scientific Lab., N. Mex.). *Phys. Rev. Letters* **4**, 237-9(1960) Mar. 1.

The Mössbauer effect was observed in the 77-kev gamma-ray line of  $\text{Au}^{197}$ . Resonance was bound using as sources either the  $\beta^-$  parent,  $\text{Pt}^{197}$ , or  $\text{Hg}^{197}$ . It was found

that the effect could be enhanced by placing the source atoms in a lattice which was mostly Au. The probabilities of emission of photons in no-photon processes and of resonant absorption from an incident beam of uniform energy spectrum were determined to be  $23 \pm 7$  and  $3 \pm 1\%$ , respectively. The mean life of  $\text{Au}^{197}$  was determined to be  $0.82 \pm 0.15 \mu\text{sec}$ . (C.J.G.)

### 13286

VARIATION WITH TEMPERATURE OF THE ENERGY OF RECOIL-FREE GAMMA RAYS FROM SOLIDS. R. V. Pound and G. A. Rebka, Jr. (Harvard Univ., Cambridge, Mass.). *Phys. Rev. Letters* **4**, 274-5(1960) Mar. 15.

The energy of the 14.4-keV  $\gamma$  ray emitted without recoil by  $0.1\text{-}\mu\text{sec}$   $\text{Fe}^{57}$  in metallic iron was experimentally determined to depend upon the temperature of the metal. (C.J.G.)

### 13287

NUCLEAR MATRIX ELEMENTS IN THE BETA DECAY OF  $\text{Sb}^{124}$ . R. M. Steffen (Purdue Univ., Lafayette, Ind.). *Phys. Rev. Letters* **4**, 290-2(1960) Mar. 15.

It is demonstrated that an unambiguous determination of nuclear matrix elements in a nonunique  $\beta$  transition as in  $\text{Sb}^{124}$  is possible on the basis of precise  $\beta$ - $\gamma$  directional and  $\beta$ - $\gamma$  circular polarization correlation measurements, if the  $\beta$  transition shows appreciable deviation from the  $\xi$  approximation. (C.J.G.)

### 13288

$\beta$ - $\gamma$  CIRCULAR POLARIZATION CORRELATION OF  $\text{Sb}^{124}$ . G. Hartwig and H. Schopper (Universität, Mainz). *Phys. Rev. Letters* **4**, 293-5(1960) Mar. 15.

It is shown that a unique determination of the 4 matrix elements  $\int \vec{r}$ ,  $\int i\sigma \vec{x}\vec{r}$ ,  $\int i\alpha$ , and  $B_{ij}$  can be achieved by measuring the  $\beta$ - $\gamma$  circular polarization correlation. The set of matrix elements derived from the experimental results on the  $\text{Sb}^{124}$  transition was in agreement with the "modified  $B_{ij}$  approximation." (C.J.G.)

### 13289

CIRCULAR POLARIZATION OF INTERNAL BREMSSTRAHLUNG ACCOMPANYING  $\beta$  DECAY. S. Galster and H. Schopper (Universität, Mainz). *Phys. Rev. Letters* **4**, 295-6(1960) Mar. 15.

The circular polarization of internal bremsstrahlung for beta transitions in the allowed decay of  $\text{P}^{32}$ , the first forbidden decay of  $\text{Bi}^{210}$ , and the unique forbidden decay of  $\text{Y}^{90}$  was determined. Corrections were applied and the results compared to theory. Good agreement with theory was obtained for  $\text{P}^{32}$  and  $\text{Y}^{90}$ , but the results for  $\text{Bi}^{210}$  were consistently lower. (C.J.G.)

### 13290

$(\alpha, t)$  REACTIONS NEAR  $Z = 28$ . J. L. Yntema (Argonne National Lab., Lemont, Ill.). *Phys. Rev. Letters* **4**, 297-9(1960) Mar. 15.

The spectra and angular distributions of the  $(\alpha, t)$  reactions on  $\text{Mn}^{55}$ ,  $\text{Co}^{59}$ ,  $\text{Cu}^{65}$ ,  $\text{Rh}^{103}$ , and  $\text{Ta}^{181}$  were determined. The  $(\alpha, t)$  reaction mechanism is discussed and it is concluded that interpretation of the gross structure in  $(\alpha, t)$  reactions in terms of single-particle states of the proton may be possible. (C.J.G.)

### 13291

POSSIBILITY OF A TEST OF THE CONSERVED VECTOR CURRENT THEORY IN THE  $A = 8$  POLYAD. Hans A. Weidenmüller (California Inst. of Tech., Pasadena). *Phys. Rev. Letters* **4**, 299-302(1960) Mar. 15.

The prediction of the  $\beta$ - $\alpha$  angular correlation functions

in  $\text{B}^8$  was used as a test of the conserved vector current theory in the  $A = 8$  polyad, assuming zero anisotropy in the  $\text{Li}^8$  correlation function. The results were in disagreement with experimental measurements. (C.J.G.)

### 13292

THE PION-NUCLEON S-WAVE SCATTERING, THE STRUCTURE OF THE NUCLEON AND THE COMPOSITE MODEL OF BARYONS AND MESONS. Yasusi Ataka (Kinki Univ., Osaka). *Progr. Theoret. Phys. (Kyoto)* **22**, 321-34(1959) Sept. (In English)

It seems impossible that the pion-nucleon s-wave scattering can be explained in the frame of meson theory. It is suggested from the experimental result that the static pion-nucleon potential with the appropriate isospin dependence has the possibility of explaining this phenomenon. The following characteristics of Fermi-Yang's composite model of pions are noticed: pions are bound states of one nucleon and one antinucleon; the attractive short range static potential exists between nucleon and antinucleon, and the repulsive short range static potential between nucleon and nucleon; the numbers of nucleons and antinucleons are independently conserved. Using this model, the static potential between a pion and a nucleon is determined. When the interaction type is vector, the static pion-nucleon potential with the charge dependence  $\tau \cdot \omega$  is given. In this case, the pion-nucleon force in the state  $I = 1/2$  becomes attractive, therefore the bound states of two nucleons and one antinucleon may be possible. This bound state of total isospin one half and spin one half is considered as the nucleon core. Then the possibility of understanding the extension and other mysterious properties of the nucleon core exists. This model is extended to every baryon and meson. (auth)

### 13293

ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. [PART]II. Kichiro Hida, Noboru Nakanishi, and Masayuki Uehara (Kyoto Univ.) and Yukihisa Nogami (Univ. of Osaka, Prefecture, Sakai, Japan). *Progr. Theoret. Phys. (Kyoto)* **22**, 351-72(1959) Sept. (In English)

The  $3\pi$ -state contributions to the isoscalar part of nucleon electromagnetic structure are explicitly calculated in the lowest order of perturbation theory (order  $g^6$ ). The detailed calculational techniques, numerical evaluations, and approximation methods are presented. The lowest order meson-structure correction to the isovector part (order  $g^4$ ) is calculated. (auth)

### 13294

POSSIBILITY OF SUPER-WEAK INTERACTIONS AND THE STABILITY OF MATTER. Yoshio Yamaguchi (European Organization for Nuclear Research, Geneva). *Progr. Theoret. Phys. (Kyoto)* **22**, 373-80(1959) Sept. (In English)

There may exist some extremely weak interactions called here "super"-weak interactions, which are much weaker than usual weak interactions. As a possible example of such interactions we discuss "metastability" of matter. (auth)

### 13295

PSEUDOSCALAR COUPLING AND S-WAVE PION-NUCLEON AND KAON-NUCLEON SCATTERING. Reiji Sugano (Kyoto Univ.). *Progr. Theoret. Phys. (Kyoto)* **22**, 381-95(1959) Sept. (In English)

The pion-nucleon s-wave scattering is investigated in the case of the Yukawa interaction of pseudoscalar coupling, making use of the Chew-Low formalism. It is shown that



the s-wave amplitude of the  $\pi$ -N scattering is strongly damped compared with the perturbation theoretic calculation. This is due to the fact that the second order matrix elements are almost cancelled by some of the fourth order ones which appear in the reduced Chew-Low equation as modified Born terms. The photo-pion production near the threshold energy is discussed on the same footing. In this case, this sort of cancellation does not occur and the amplitudes for this process remain unchanged. The charge ratio of photo-pion productions was calculated at the threshold energy and a value (2.27) which is larger than the experimental one ( $1.87 \pm 0.13$ ) was obtained. In addition the low energy kaon-nucleon and the pion-hyperon scattering are treated in a similar manner. (auth)

### 13296

STRONG INTERACTIONS AND BARYON MASS LEVELS. Brian Bransden and Gordon Moorhouse (The University, Glasgow). *Progr. Theoret. Phys. (Kyoto)* **22**, 396-402 (1959) Sept. (In English)

Using a cut-off version of the Hamiltonian of d'Espagnat and Prentki for the strong interactions and assuming the baryons form a mass degenerate system in the absence of interaction, it is shown that the observed baryon mass spectrum is consistent with values of the coupling constants suggested by the dynamical processes, such as  $\pi$  meson-nucleon and  $K^+$  meson-nucleon scattering. The  $\pi$  meson-baryon interaction was taken to be of the  $(\sigma \cdot \nabla)$  type and that of the K meson-baryon interaction to be of the  $\gamma_5$  type, and the Rayleigh-Ritz method using a simple one-meson trial wave function is used to calculate the masses. (auth)

### 13297

APPLICABILITY CONDITIONS OF THE HYDRODYNAMICAL MODEL OF MULTIPLE PRODUCTION OF PARTICLES FROM THE POINT OF VIEW OF QUANTUM FIELD THEORY. Chikashi Iso (Kyoto Univ.); Kenju Mori (Tokyo Univ.) and Mikio Namiki (Waseda Univ., Tokyo). *Progr. Theoret. Phys. (Kyoto)* **22**, 403-29(1959) Sept. (In English)

In the framework of quantum field theory, it is attempted to investigate whether the hydrodynamical description is applicable to the meson cloud produced in extremely high energy collisions of nucleons as considered in Landau's theory of the multiple production of particles. The applicability conditions of the hydrodynamical model consist of local equilibrium and conditions for the possibilities of defining the local system in the meson cloud, which are prepared by the methods based on quantum statistical mechanics of irreversible processes. These conditions are examined by comparison of the correlation lengths and the relaxation times of the meson fluid with a characteristic length and time, in which the thermodynamical parameters, the temperature for example, of the fluid decrease or increase by an appreciable amount on a macroscopic scale. From such examinations, it may be concluded that the hydrodynamical model holds almost everywhere except in the front part of the cloud after the whole cloud spreads over a region whose size is the order of the correlation length. It is emphasized that the interactions in the initial cloud directly after collision and in the front part of the expanding cloud can never be described by any statistical law or hydrodynamics. The fact that the front particles are never in any thermal equilibrium suggests that they remember some features of initial high energy interactions in the very small cloud. It is inferred that the distributions (for example,  $K/\pi$  ratio and the momentum or angular distribution) of the front particles may be informative about

the interactions at very small distances. The influences of initial interactions on the remaining cloud are only taken into account through the initial boundary conditions for the hydrodynamical equation. In addition, it is pointed out that the assumption of the perfect fluid used by Landau is not so good; it turns out that one can expect an increment of the number of particles through the final interactions. Finally it is discussed whether these characteristics may be consistent with the recent experiments. (auth)

### 13298

PION PRODUCTION IN PION-NUCLEON COLLISION WITH ASSUMPTION OF STRONG PION-PION INTERACTION. Daisuke Ito, Miwae Yamazaki, Tetsuro Kobayashi, and Kenju Mori (Tokyo Univ. of Education). *Progr. Theoret. Phys. (Kyoto)* **22**, 448-51(1959) Sept. (In English)

The results of a hypothetical analysis of pion production at 1.4 Bev in strong pion-pion interactions are given. From this investigation at 1.4 Bev, results were obtained for the incident pion for the following: angular and momentum distribution of emitted particles; branching ratio; and contributions from separate partial waves. The simplest type of  $\pi$ - $\pi$  interaction was considered, and no definite conclusions can be drawn about the evidence of strong  $\pi$ - $\pi$  interactions. (B.O.G.)

### 13299

BRANCHING RATIOS FOR THE  $K^-$  CAPTURE FROM HYDROGEN AT LOW ENERGY. Ken Kawanabayashi (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)* **22**, 451-2(1959) Sept. (In English)

Several attempts were made to explain the behavior of the branching ratios and it developed that the hypothesis of the global symmetry was incompatible with these ratios under the assumption that the K-meson-baryon coupling is weak and  $\Sigma' - \Lambda^0$  mass difference can be neglected. It is pointed out that a rather natural explanation of the branching ratios for the  $K^- + p \rightarrow \Sigma^{*0} + \pi^0$  may be possible for appropriate magnitude of the pion-baryon coupling constants. The incompatibility of the global symmetry hypothesis with the reaction ratios is made clear. It is noticed that this conclusion is insensitive to the  $\Sigma - \Lambda$  mass difference and to the magnitude of the K-meson-baryon coupling constants. (B.O.G.)

### 13300

ANGULAR DISTRIBUTIONS OF ( $^{14}\text{N}, \alpha$ ) REACTIONS. Tetsuo Kammuri (Osaka Univ.) and Ryuzo Nakashima (National Research Council, Washington, D. C.). *Progr. Theoret. Phys. (Kyoto)* **22**, 458-9(1959) Sept. (In English)

The 26-Mev  $\text{N}^{14}$  bombardment of  $\text{O}^{16}$  was investigated to determine the angular distribution of  $\alpha$  particles emitted from the  $\text{O}^{16}(\text{N}^{14}, \alpha)\text{A}^{16}$  reaction. According to an analogy of the stripping process, the nitrogen nucleus was considered to be:  $\text{N}^{14} \rightarrow \text{B}^{10} + \alpha$ . During the bombardment the  $\text{B}^{10}$  was captured by the target while the alpha particle escaped. The angular distribution and differential cross sections of the  $\alpha$  particles emitted in the reaction were determined. (B.O.G.)

### 13301

ENERGY LEVELS OF  $\text{Zr}^{90}$ . V. K. Thankappan and Y. R. Waghmare (Physical Research Lab., Ahmedabad, India). *Progr. Theoret. Phys. (Kyoto)* **22**, 459-61(1959) Sept. (In English)

The low-lying energy levels in  $\text{Zr}^{90}$  were measured by Lazar et al. and found to agree with the qualitative conjectures of Ford. Quantitative calculations by Lane based on short-range interactions between nucleons give poor agreement with observed splittings of the  $(g_{7/2})^2$  configura-

tion. Calculations were made for a more realistic shell model level scheme by taking a finite range for nuclear interactions and results were obtained which were in better agreement with the experimental results. (B.O.G.)

### 13302

ON THE DIFFRACTION INTERACTION OF FAST DEUTERONS WITH NONSPHERICAL NUCLEI. A. G. Sitenko and Yu. A. Berezhnoi (Kharkov State Univ.). *Ukrain. Fiz. Zhur.* **4**, 564-8(1959) Sept.-Oct. (In Ukrainian)

The diffraction scattering of fast deuterons on a black nonspherical nucleus having the shape of an ellipsoid of rotation is considered. Integral cross sections are found for the possible diffraction processes of scattering, absorption, and diffraction splitting of the deuteron and stripping of the neutron or proton. All integral cross sections are expressed by averaged (for all orientations of the axis of symmetry of the nucleus) areas and the perimeter of the ellipsoidal shadow of the nucleus on a plane perpendicular to the wave vector of the incident deuteron. (auth)

### 13303

ON INELASTIC SCATTERING OF NEUTRONS AND PROTONS BY NUCLEI. A. G. Sitenko and V. F. Kharchenko (Gor'kii Kharkov State Univ.). *Ukrain. Fiz. Zhur.* **4**, 569-76(1959) Sept.-Oct. (In Ukrainian)

Direct inelastic scattering of nucleons on light nuclei by interaction of the incident nucleon with the external nucleon of the nucleus is considered. The interaction with the nucleus core is taken into account, using a diffraction model. The single particle wave functions of the nucleus were chosen according to the shell model with oscillator potential. As an example, the calculations of angular distribution were carried out for the case of inelastic proton scattering on  $\text{Si}^{28}$ . (auth)

### 13304

EFFECT OF TIN ON PROPERTIES OF TITANIUM. Karl Bungardt and Hans Hermann Weigand (Forschungsinstitut der Deutsche Edelstahlwerke AG, Krefeld, Ger.). *Z. Metallk.* **51**, 181-5(1960) Mar. (In German)

Experiments with titanium alloys with up to 10% tin show that the  $\alpha$ - $\beta$  transformation of titanium is shifted by tin to lower temperatures, i.e., tin may be regarded as  $\beta$ -stabilizing alloying element. The influence of the tin addition on different properties and the heat treatment are discussed. (auth)

### 13305

GROUP THEORETICAL INVESTIGATIONS ON THE SHELL MODEL. II. THE PROBLEM OF TRANSLATION INVARIANCE. Martin Kretschmar (Universität, Göttingen, Ger.). *Z. Physik* **158**, 284-303(1960). (In German)

In a previous paper a group theoretical scheme for the classification of wave functions was developed from a consideration of the group of all transformations, which leave the nuclear hamiltonian invariant, thereby taking into account also accidental degeneracies. This scheme is applied to a translation-invariant hamiltonian with harmonic oscillator forces. The existence of a shell structure for the ground states is proved, and the quantum numbers and symmetry properties of the wave functions of the ground states and of some excited states are derived. If translation-invariance is neglected, spurious states appear. It is shown how their quantum numbers and symmetry properties can be determined. Some remarks on a translation-invariant formulation of the Elliot model conclude the paper. (auth)

### 13306

CALCULATION OF MATRIX ELEMENTS IN THE BETA-

DECAYS OF  $\text{Sc}^{44}$  AND  $\text{Mn}^{52}$ . P. S. Kelly and S. A. Moszkowski (Univ. of California, Los Angeles). *Z. Physik* **158**, 304-11(1960). (In English)

Recent experiments make possible the approximate determination of mixing ratios  $\int \sigma/f$  for several nuclei in  $J \rightarrow J$  beta transitions. It is verified that the signs of these ratios in two nuclei ( $\text{Sc}^{44}$  and  $\text{Mn}^{52}$ ) are consistent with plausible assumptions about the nature of the nuclear wavefunctions, as determined using the  $j-j$  coupling nuclear shell model. (auth)

### 13307

DECAY SCHEME AND  $\beta$  SPECTRUM OF  $\text{MsTh}_1$  ( $\text{Ra}^{228}$ ). Gerhard Goetze (Universität, Marburg, Ger.). *Z. Physik* **158**, 347-58(1960). (In German)

The  $\beta$  spectrum of  $\text{MsTh}_1$  ( $\text{Ra}^{228}$ ) was measured in a proportional counter in  $2\pi$  and in  $4\pi$  geometry. Comparison of these measurements shows that there are no conversion electrons. The  $\beta$  decay of  $\text{MsTh}_1$  therefore leads in all cases to the ground level of  $\text{MsTh}_2$ . The Kurie plot is straight from 15 kev up to the upper energy limit of  $E_0 = 55 \pm 3$  kev ( $\log ft = 5.6$ ). The result was checked by a search for photons emitted by the  $\text{MsTh}_1$ . No  $\gamma$  rays and no  $x$  rays were found. The measurements had to be made with a relatively large amount of natural  $\text{Ra}^{228}$  in the sources. The results do not agree with those of Lecoin, Perey, Teillac, and Riou, who proposed a complex decay scheme for  $\text{MsTh}_1$ . (auth)

### 13308

TABELLEN DER ATOMKERNE. TEIL I. EIGENSCHAFTEN DER ATOMKERNE. BAND 1. DIE ELEMENTE NEUTRON BIS ZINN. (Nuclear Tables. Part I. Nuclear Properties. Volume I. The Elements from Neutron to Tin). Wunibald Kunz and Josef Schintlmeister. Berlin, Akademie-Verlag, 1958. 500p.

All the data published between January 1, 1940, and January 1, 1958, on the nuclear properties of the stable and radioactive nuclei from the neutron up to tin are tabulated. The data were examined critically and are classified in the tables according to their reliability. Most of the data were obtained from the original reports. In the cases where the original was not available, no evaluation of the data was made. (J.S.R.)

### 13309

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires.

DISTRIBUCION ANGULAR EN  $\text{C}^{13}(\text{d},\text{t})\text{C}^{12}$  7.65 MEV. Informe No. 13. (Angular Distribution in  $\text{C}^{13}(\text{d},\text{t})\text{C}^{12}$  at 7.65 Mev). Report No. 13. S. Mayo. 1959. 8p.

A 66%  $\text{C}^{13}$  target was bombarded with 14.8 Mev deuterons. The triton group corresponding to the 7.65 Mev level in  $\text{C}^{12}$  was magnetically analyzed and detected with a scintillator at laboratory angles between 10 and 70°. The angular distribution shows good agreement with Butler theory for  $l_n = 1$ ,  $r_0 = 5.5 \times 10^{-13}$  cm; the cross section at the maximum of the angular distribution is  $0.38 \pm 20\%$  mb/sterad. The reduced width of the level relative to the ground state in  $\text{C}^{12}$  is 0.043. (auth)

### 13310

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires.

INTERACCION DE DEUTERONES DE 14.8 MEV CON CARBONO. Informe No. 14. (Interaction of Deuterons at 14.8 Mev with Carbon). Report No. 14. S. Mayo and A. I. Hamburger. 1959. 29p.

A target enriched to 66% in  $\text{C}^{13}$  was bombarded with 14.8 Mev deuterons. Angular distributions of tritons from



$C^{13}(d,t)C^{12}$  reactions corresponding to the ground and first excited states of  $C^{12}$  were obtained. They were compared with Butler's theory of pick-up reactions and the best agreement was found for  $l_n = 1$ ,  $r_0 = 4.6 \times 10^{-13}$  cm, and  $l_n = 1$ ,  $r_0 = 5.0 \times 10^{-13}$  cm, respectively. The cross sections were 19.5 mb/sterad  $\pm 20\%$  at  $\theta$  cm =  $12^\circ$  for the ground state and 8.0 mb/sterad  $\pm 20\%$  at  $\theta$  cm =  $12.5^\circ$  for the 4.43 Mev level in  $C^{12}$ . The ratio of reduced widths were  $\Theta^2(4.43\text{Mev})/\Theta^2(\text{GS}) = 0.74$ . The angular distribution of the  $C^{12}(d,p)C^{13}$  GS was also obtained and compared with stripping theory for  $l_n = 1$ ,  $r_0 = 4.6 \times 10^{-13}$  cm. The cross section was 15.7 mb sterad  $\pm 20\%$  at  $\theta$  cm =  $14.5^\circ$ ; the reduced width was  $\Theta^2 = 0.033 \pm 20\%$ . The ratio of cross sections of  $C^{13}(d,t)C^{12}$  GS to  $C^{12}(d,p)C^{13}$  GS yields a quantity proportional to the probability that a triton is formed by a deuteron plus a second neutron:  $|A_0|^2 N_i^2 = 1.3 \times 10^{13} \text{ cm}^{-1} \pm 20\%$ . This factor was also obtained from the ratio  $C^{13}(d,t)C^{12}$  4.43 Mev to  $C^{13}(p,d)C^{12}$  4.43 Mev:  $|A_0|^2 N_i^2 = 1.0 \times 10^{13} \text{ cm}^{-1} \pm 20\%$ . (auth)

### 13311

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires.

ESTADOS EXCITADOS DEL  $\text{Ba}^{136}$ . Informe No. 22. (Excitation States in  $\text{Ba}^{136}$ ). Report No. 22. Sonia J. Nassiff, Juan J. Peyre, and Tauba Urstein. 1959. 10p.

With a scintillation spectrometer, relative intensities and gamma-gamma coincidences of the rays emitted during the disintegration of  $\text{Cs}^{136}$  were determined. (auth)

## Particle Accelerators

### 13312 AERE-R-3255

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

SPACE-CHARGE EFFECTS IN CYLINDRICAL BEAMS WITH UNIFORM ACCELERATION. C. D. Moak. Feb. 1960. 28p. BIS.

An evaluation was made of the integral which describes the profiles of cylindrical beams of particles, converging toward parallel emergence from a uniform voltage gradient accelerator. Tables are presented which cover variations of the parameters. (C.J.G.)

### 13313 CERN-60-5

European Organization for Nuclear Research, Geneva. ETUDE ET REALISATION DE BIPRISMES ELECTROSTATIQUES UTILISABLES EN OPTIQUE CORPUSCULAIRE. (Study and Construction of Electrostatic Biprisms Useful in Corpuscular Optics). A. Septier. Mar. 3, 1960. 25p.

In the simultaneous injection of two beams identical except in direction in an FFAG cyclotron, two beams of equal intensity and energy are needed. The two beams can be produced either by alternating the direction of a single beam by very short, rectangular, high-voltage pulses fed to a deflector, or by chopping the beam with a static apparatus. The second method was investigated because of its simplicity. The principles and properties of the electrostatic biprism are presented. Three cases are then considered: a wire stretched between two plates, a grid between two plates, and a plate between two flat conductors. (T.R.H.)

### 13314 CERN-60-6

European Organization for Nuclear Research, Geneva. LES LENTILLES MAGNETIQUES QUADRUPOLAIRES SANS FER: REALISATION DE REPARTITIONS D'INDUC-

TION A GRADIENT CONSTANT. (Quadrupolar Magnetic Lenses without Iron: Construction of Induction Sectors with Constant Gradient). Albert Septier. Mar. 10, 1960. 47p.

The usefulness of magnetic lenses with strong convergence without iron cores for magnetic induction sectors with constant radial gradient is pointed out, and an investigation is made of the possibilities. To simplify the energization problems, the field created by systems of conductors with uniform current density is considered. The expressions for the potential and for the field of systems with quadrupolar symmetry are given, and a study made of the approximations more and more nearly obtained in a larger and larger space surrounding the axis, using 4 wires, then 4 levels of current, and finally 4 thick coils of rectangular cross section. The conductors are supposed to be indefinite according to an Oz axis, which leads to induction sectors with only two dimensions. (T.R.H.)

### 13315 MURA-488

Midwestern Universities Research Assn., Madison, Wis. LONGITUDINAL SPACE CHARGE EFFECTS—INFLUENCE OF ENERGY LOSS. C. E. Nielsen and A. M. Sessler. July 1959. Revised Mar. 25, 1960. 16p. Contract AT(11-1)-384. OTS.

An analysis of the longitudinal stability of a coasting beam is extended to include the effect of an energy loss linearly dependent upon particle energy. Consideration is restricted to the case of a beam of uniform phase space density within sharp boundaries. By suitable transformations, the equations are expressed in terms of canonical coordinates and momenta. Approximate solutions are obtained after linearization. It is found that instabilities of charge density develop above transition energy when the energy spread of the beam decreases with time; the effect of the energy loss mechanism upon instability growth rate is computed. (auth)

### 13316 MURA-555

Midwestern Universities Research Assn., Madison, Wis. ELECTROMAGNETIC FIELDS IN A DONUT SPACE. W. N. Wong. Jan. 22, 1960. 26p. Contract AT(11-1)-384. OTS.

The electromagnetic field in a donut shaped finite space is studied in some detail by assuming the source which excites the field to be a given function of space-time. In the interest of simplicity, this prescribed source function is further assumed to be one-dimensional. Green's functions are used in order to put the solutions in integral representation form so that if coupling between the source and the field is later introduced, the complete physical situation can be taken care of by a complicated integral equation. (auth)

### 13317 MURA-558

Midwestern Universities Research Assn., Madison, Wis. ON ROBINSON'S MULTIPLE FREQUENCY ACCELERATOR. G. Bronca. Feb. 4, 1960. 20p. Contract AT(11-1)-384. OTS.

The effects on the accelerated particles of frequencies, other than the bucket frequency, were studied. Particles near the separatix were lost when adjacent frequencies were too close to the bucket frequency. An expression for the beam intensity is given and compared with the case of frequency modulated cavities. The duty cycle at injection is shown to be high (10 to 30%) for a constant current injector. (auth)

### 13318 MURA-560

Midwestern Universities Research Assn., Madison, Wis. ADIABATIC BEHAVIOR NEAR TRANSITION ENERGY. G. Bronca. Mar. 1, 1960. 14p. Contract AT(11-1)-384. OTS.

Computer results for the behavior of particles near transition energy in FFAG accelerators are compared with analytical studies of the limit of adiabatic motion. (auth)

### 13319 UCRL-9057

California. Univ., Berkeley. Lawrence Radiation Lab. LINAC INJECTION FOR THE 340-MEV BERKELEY ELECTRON SYNCHROTRON. PART I—THEORETICAL. K. C. Crebbin and J. R. Hiskes. Jan. 1960. 24p. Contract W-7405-eng-48. OTS.

The problem of multiturn injection into the 340-Mev electron synchrotron utilizing the 2-Mev beam from the r-f linear electron accelerator is discussed. The details associated with inflection are ignored; primary attention is given to estimating the acceptance requirements for the betatron and synchrotron oscillations. Two methods of injection are examined: injection at constant energy and injection with energy increasing with the magnetic field. Under somewhat idealized assumptions regarding the output properties of the linac beam, it is estimated that a trapped-beam current could be obtained which is several factors larger than the present beam using betatron injection. Since the angular properties of the beam from the linac are appreciably poorer than the idealized assumption, it appears that the probability of increasing the present synchrotron beam intensity using these injection methods is small. (auth)

### 13320 UCRL-Trans-531

CASCADE GENERATORS FOR ACCELERATING PARTICLES TO 4 MeV. (Kaskaden-generatoren zur Partikelbeschleunigung auf 4 MeV). Walter Heilpern. Translated by Richard B. Mudge from *Helv. Phys. Acta* 28, 485-91(1955). 17p. (Includes original, 7p.). JCL.

A method for reducing the marked waviness of the output voltage of a cascade generator is described. The method consists of symmetrizing the connection to a series of rectifiers and condensers over a high ohm resistance. The design parameters of a cascade generator for particle acceleration to 4 Mev are given. (C.J.G.)

### 13321

ON THE DAMPING OF PHASE OSCILLATIONS IN A WEAK-FOCUSING SYNCHROTRON. R. Klíma (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). *Czechoslov. J. Phys.* 10, 136-43(1960). (In Russian)

An equation for the phase oscillations in a weak-focusing synchrotron was derived for the case of an arbitrary high-frequency field of sinusoidal time dependence being distributed on the circumference of the accelerator. It is shown that the damping of phase oscillations is practically independent of the shape of the high-frequency field. Therefore any adjustments to the accelerator gaps would be useless. (auth)

### 13322

BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A GENERAL FIELD. [PART] I. J. Teichman (Inst. of Vacuum Electronics, Czechoslovak Academy of Science, Prague). *Czechoslov. J. Phys.* 10, 144-57(1960). (In Russian)

A linear theory of equilibrium trajectories in an accelerator with a generalized magnetostatic field is given, the components of which are defined on a general rotation surface. Equations of motion of the particles in natural coordinates were derived with respect to the change in energy and dissipative force. A system of equilibrium trajectories was found in the general form. Conditions for the field components on the reference surface, for the

conservation of their geometric similarities and for maintaining the constancy of the frequencies of the betatron oscillations, were derived. A condition was derived which must be satisfied by the reference surface to conserve constant circular frequency of the particles. It is seen that it is not possible to find a field for an accelerator with an exactly constant circular frequency and with constant frequencies of the betatron oscillation in the relativistic energy region. An ultra-relativistic cyclotron with such properties is realizable. (auth)

### 13323

CERN'S 25 GEV PROTON SYNCHROTRON. NOTABLE INTERNATIONAL PROJECT. *Nuclear Energy* 14, 147-51 (1960) Apr.

A description is presented of CERN's 25-Bev proton synchrotron including its specifications. The magnet size is compared to the magnet of the Russian 10-Bev synchrophasotron, which is ten times heavier and has three-tenths the radius of the CERN magnet. The cost of the synchrotron is estimated to be about 120m Swiss francs or about £10m. This cost is divided among the 13 nations which make up CERN. The percentages of the total contributions made by each country are given. (B.O.G.)

### 13324

ELECTROSTATIC MACHINES AT GRENOBLE. NEW TYPES OF PARTICLE ACCELERATORS HAVE BEEN DEVELOPED. *Nuclear Power* 5, No. 48, 136-7(1960) Apr.

The characteristics of Felici particle accelerators developed by a French industrial firm, SAMES, are discussed. The generators are controlled by regulation and stabilization circuits and very high voltage stabilities can be obtained. The "Samtron" output voltage is stable to 1 part in  $10^5$  at 100 kv. The voltage ranges of these generators extend from 40 kv to 1.2 Mv with currents of 30  $\mu$ a to 50 ma. Uses of Felici electrostatic generators with the particle generators to produce high-voltage pulses are discussed. (B.O.G.)

### 13325

MAXIMIZING PRODUCTION OF RADIOISOTOPES IN A CYCLOTRON. Farno L. Green and John A. Martin (Oak Ridge National Lab., Tenn.). *Nuclear Sci. and Eng.* 7, 387-91(1960) Apr.

The radioisotopes  $Mn^{54}$ ,  $I^{125}$ , and  $I^{130}$  were produced at higher rates and at lower cost when targets of isotopically enriched  $Cr^{54}$ ,  $Te^{125}$ , and  $Te^{130}$  were bombarded with protons in the ORNL 86-inch Cyclotron. The product isotopes were carrier-free and relatively free of undesired radioisotopes. The use of enriched isotopes as cyclotron targets is economically attractive when they can be recovered and reused. To obtain the maximum production rate for radioisotopes in a cyclotron, both the usable beam power and the excitation function of the nuclear reaction must be considered. (p,n) reaction production rates were increased by a factor of 1.7 by decreasing the proton energy from 22 to 18 Mev and doubling the output current. Methods of reducing the energy below the maximum design value are discussed. (auth)

### 13326

PRELIMINARY RESULTS OF THE DETERMINATION OF THE BREMSSTRAHLUNG SPECTRUM OF THE ELECTRON SYNCHROTRON AT FRASCATI. G. Diambri (Comitato Nazionale per le Ricerche Nucleari, Frascati, Italy); A. S. Figuera and A. Serra (Comitato Nazionale per le Ricerche Nucleari, Rome); and B. Rispoli (Comitato Nazionale per



le Ricerche Nucleari, Rome and Università, Rome).  
 Nuovo cimento (10) 15, 500-3(1960) Feb. 1. (In Italian)

Preliminary bremsstrahlung spectrum data are given for the Frascati electron synchrotron. The experimental set-up consisted of a 100-Mev electron beam converging on a Ta converter, a collimating assembly connected by an evacuated cylinder to the spectrometer with an Al converter and an arrangement of scintillation counters. The results are in the form of a graph which compares the data with theory (Bethe-Heitler and Wheeler-Lamb), with theory corrected for scattering in the spectrometer converter, and with theory corrected for counter resolving power. (T.R.H.)

### 13327

CONTROL AND CALIBRATION OF THE BETATRON ENERGY SCALE. K. N. Geller and E. G. Muirhead (Univ. of Pennsylvania, Philadelphia). *Rev. Sci. Instr.* 31, 308-13 (1960) Mar.

A new system for control of the x-ray energy from a 25-Mev betatron is described. Modifications in the method of energy control and orbit expansion lead to improved operation. Calibration of the energy scale is based on reaction thresholds for  $D(\gamma, n)$ ,  $Bi^{209}(\gamma, n)$ ,  $Cu^{63}(\gamma, n)$ , and the threshold for excitation of the 15.116-Mev state in  $C^{12}$ . The resulting energy scale is linear with respect to electron momentum to better than  $\pm 20$  kev. (auth)

### 13328

National Research Council. Committee on Nuclear Science.

SECTOR-FOCUSED CYCLOTRONS. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959. F. T. Howard, ed. 1959. 305p. \$2.50 (NAS-NRC).

Its Nuclear Science Series, Preliminary Report No. 26.  
 The Conference on sector-focused cyclotrons centered attention on problems associated with the design and construction of a new type of fixed-frequency cyclotron in which azimuthal variations in the magnetic field provide axial focusing for large ion currents and also permit the radial increase in average magnetic required field for the acceleration of ions to relativistic energies. Considerable attention was given to development of the ion orbit theories, calculation of complex magnetic field configurations, and to measurements made with model magnets. Special features for improving beam quality, providing variable frequency to accelerate different ions to various energies, and for improving beam deflection were discussed. (W.D.M.)

### 13329

California. Univ., Los Angeles.  
 A SIMPLIFIED APPROACH. J. Reginald Richardson. p.7-11 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A simplified approach to the problems of orbit theory in relatively small machines is described, which avoids the complexity of resorting to a digital computer but yields reasonable accuracy for most purposes. Results are illustrated by a description of the UCLA design for a 50-Mev proton cyclotron of four-fold symmetry with high magnetic field and small magnetic gap. Correction of errors in phase by use of a minimum number of concentric trimming coils on the pole faces is considered. (W.D.M.)

### 13330

Pittsburgh. Univ.  
 SELECTION OF MAGNET CONFIGURATION FOR THE ORIC. Bernard L. Cohen. p.15-17 of "Sector-Focused

Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The line of reasoning used to determine the principal parameters for the ORIC so as to achieve suitable orbit stability is explained. The behavior in the central region was crucial in the considerations, particularly since the large gap desired prevents reliance on flutter focusing near the center; valley coils were felt to be helpful, and three-fold symmetry was decided on to minimize complications in the central region and to facilitate deflection for which this choice was felt to offer advantages. (W.D.M.)

### 13331

Birmingham. Univ., England.  
 THE UNIVERSITY OF BIRMINGHAM RADIAL-RIDGE CYCLOTRON. W. B. Powell. p.12-14 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A simplified discussion of orbit properties in the Birmingham radial-ridge cyclotron is presented. The cyclotron has a small gap and a magnetic field up to 19 kilogauss. The principal features of the machine are discussed. (W.D.M.)

### 13332

Florida. Univ., Gainesville.  
 SPIRAL RIDGE STUDIES AT THE UNIVERSITY OF FLORIDA. N. Marshall King. p.18-28 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Attention is directed to a comprehensive report on measurements of magnetic fields produced by rectangular ridge structures and the application of this data to the design of sector-focused cyclotron fields is discussed in detail. Model and design work for a 400-Mev machine at the University of Florida is described. In one case a transition from 3-fold to 6-fold symmetry at an intermediate radius was considered. (W.D.M.)

### 13333

Delft, Netherlands. Technische Hogeschool.  
 DESIGN AND PERFORMANCE OF A 12-MEV ISOCHROUS CYCLOTRON. F. A. Heyn and Khoe Kong Tat. p.29-39 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Design and performance data are presented for the 12-Mev proton cyclotron at Delft, which is the first sector-focused machine for protons to come into operation. Particular interest was attached to a description of an anomalous highly eccentric beam of low energy particles which was observed under some circumstances, but could be eliminated by increasing the magnetic field at the center. It may have been related to asymmetries in the r-f electric field. (W.D.M.)

### 13334

Midwestern Universities Research Assn., Madison, Wis.  
 CALCULATING ORBIT PROPERTIES OF F-F CYCLOTRONS. George Parzen. p.40-44 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Analytical results for calculating various orbit properties of fixed frequency cyclotrons are discussed. Some rather general and complicated formulas are presented for the various quantities of interest, including nonlinear stability limits for the important resonances. The relative importance of the various terms are discussed and results are compared with those obtained with other techniques. (W.D.M.)

**13335**

[California. Univ.], Berkeley. Lawrence Radiation Lab. ORBIT STUDIES RELATED TO THE BERKELEY 88-INCH CYCLOTRON. Lloyd Smith. p.45-7 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The Berkeley theoretical program is traced through the early stages of simplified theory, on to general analytical work and then to detailed work on digital computers using MURA and ORNL codes. Detailed comparisons among the numerical work with different codes and the evaluation of analytical formulas are presented, including work on the stability limits at resonances. (W.D.M.)

**13336**

Oak Ridge National Lab., Tenn. COMPUTER CODES FOR CYCLOTRON ORBIT CALCULATIONS. T. A. Welton. p.48-54 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The philosophy of cyclotron orbit work at ORNL and ORNL codes which are available are described in detail. With the best of these, for an IBM-704, one can obtain the complete properties of an orbit in six seconds, starting from a specification of the magnetic field by giving field values on a mesh of points. These values could have as their source either an analytical representation of the field or a set of measurements in a model magnet. (W.D.M.)

**13337**

Midwestern Universities Research Assn., Madison, Wis. DIGITAL COMPUTER PROGRAMS AT MURA. Keith R. Symon. p.55-8 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

MURA codes are described which have been developed over a period of years for purposes somewhat more general than cyclotron design. The codes form a connected set by which magnetic pole shapes, field values, and orbit properties may all be interrelated in a comprehensive way. (W.D.M.)

**13338**

Michigan State Univ., East Lansing. ORBIT CALCULATIONS FOR MSU CYCLOTRON. H. G. Blosser. p.59-65 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Computations are described which bear on the design of a 50-Mev variable-energy multiple-particle cyclotron being planned for Michigan State University. To use three sectors in the machine, the extent to which the beam will be disturbed by the strong  $\nu_r = \frac{3}{2}$  resonance must be checked. The computations are concerned mainly with ascertaining the precise effects of this resonance. (W.D.M.)

**13339**

Florida. Univ., Gainesville. ORBIT STABILITY IN THREE- AND FOUR-SECTOR CYCLOTRONS. M. M. Gordon. p.66-72 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

It is shown that adequate stability can be obtained in machines with three-fold symmetry. Calculations indicate that axial stability near deflection is actually better for  $N = 3$  than for  $N = 4$ . (W.D.M.)

**13340**

Michigan. Univ., Ann Arbor. ORBIT DYNAMICS FOR A FOUR-SPIRAL-SECTOR

CYCLOTRON. Kent M. Terwilliger. p.73-5 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Orbit studies are described for a four-sector, tight spiral machine for 40-Mev deuterons. For such machines the "smooth approximation" results appear quite reliable as judged by digital work with the MURA codes. Special attention is given to nonlinear axial motion effects, coupling resonances, and unwanted first harmonic perturbations. It is concluded that the tight spiral design is quite reasonable. (W.D.M.)

**13341**

Colorado. Univ., Boulder. GENERAL ORBITS IN THE CYCLOTRON. D. A. Lind. p.76-8 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Experimental and calculational work on the first few turns of the University of Colorado cyclotron is described. The space dependence of the r-f electric field was found from a model and approximated by analytical functions. Calculations of radial and axial motion led to numerical estimates of the phase space injected, of the amplitude of radial oscillation to be expected at the deflector, and of phase bunching as well as of axial electric focusing. (W.D.M.)

**13342**

Watson Scientific Computing Lab., New York. A METHOD OF COMPUTING FOR NEARLY PERIODIC ORBITS. L. H. Thomas. p.79-83 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Attention is directed to the possible advantages, in computing nearly periodic orbits, of applying computational methods long known in celestial mechanics by which one extrapolates forward by several cycles, rather than by small steps along the orbit. (W.D.M.)

**13343**

Illinois. Univ., Urbana. THE UNIVERSITY OF ILLINOIS SPIRAL-RIDGE CYCLOTRON. James S. Allen. p.89-96 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Problems involved in converting the University of Illinois cyclotron into a flexible, variable-energy machine are described. Spiral shims and field coils have been added to the machine. Model measurements, construction of parts, and the field configuration are discussed. (W.D.M.)

**13344**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. A 4-Mev SPIRAL-RIDGE CYCLOTRON. M. Snowden. p.97-103 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A proton model is described which is designed to simulate the central region of the proposed conversion of the 110-in. Harwell cyclotron. It has a spiral R equal to 0.15  $\theta$  and a 4-in. gap at minimum. The magnet with the pole pieces, coils, and the field measuring equipment are discussed. (W.D.M.)

**13345**

Oak Ridge National Lab., Tenn. OAK RIDGE MODEL MAGNET STUDIES. E. D. Hudson.



p.104-9 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The approximately  $\frac{1}{6}$  scale model has been satisfactory for determining the efficiency, forces, number of sectors, and some estimate of the ampere-turns required in the valley coils, the harmonic coils, and the circular trimming coils, but has not provided suitable data for detailed orbit calculations. (W.D.M.)

### 13346

[California. Univ.]. Berkeley. Lawrence Radiation Lab. THE BERKELEY 88-INCH CYCLOTRON MAGNET. C. G. Dols. p.110-20 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Some full-scale magnet problems are discussed and some of the procedures and results are described. Magnet optimization, model magnet, magnetic measurements, radial profile shaping, azimuthal average search coil system, and the effect of magnet coil position are discussed. (W.D.M.)

### 13347

Michigan State Univ., East Lansing. ADJUSTMENT OF TRIMMING-COIL CURRENTS. H. G. Blosser. p.121-4 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A method for adjusting trimming-coil currents is presented. The method is based on field measurements and least-square fitting procedures with a computer being used to do the actual calculating. The method is essentially a closed loop; measurements are plugged in and the answers grind out. (W.D.M.)

### 13348

Naval Radiological Defense Lab., San Francisco. MODEL MAGNET WORK AT NRDL. H. A. Howe. p.125-9 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Certain saturation effects in the ridges of the cyclotrons and possible uses of the saturation effects are discussed. Alternative methods of making a good variable-energy machine are investigated. It is assumed that the change in the average magnetic field due to saturation effects will be determined by the saturation of the ridges, and that the valley iron will remain essentially unsaturated and at an equimagnetic potential. (W.D.M.)

### 13349

California. Univ., Los Angeles. THE UCLA 50-Mev SPIRAL-RIDGE CYCLOTRON. Byron T. Wright. p.130-4 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Magnetic field measurements on the magnet model for the 50-Mev spiral-ridge cyclotron are described. The magnet was converted from a synchrocyclotron and, to obtain the same energy, dees were put in the valleys only and full use was made of small gaps over the hills. (W.D.M.)

### 13350

Florida. Univ., Gainesville. A SPIRAL-RIDGE ELECTRON MODEL CYCLOTRON. D. L. Lafferty. p.135-9 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

An electron model cyclotron is described which was designed to gain practical experience in handling the problems associated with the production and analysis of non-uniform fields. Neither the chosen field variation nor the construction techniques represent a very realistic approach for proton machines. The field modulation is sinusoidal which means that, even though the field is mathematically simple in form, the required poleface contours are difficult to construct. (W.D.M.)

### 13351

California. Univ., Los Angeles. THE DEE-IN-VALLEY RADIO-FREQUENCY SYSTEM AT UCLA. K. R. MacKenzie. p.143-9 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The general question of the location, size, and orientation of the accelerating electrodes in the magnet gap is discussed. It is pointed out that the only practical arrangement for large cyclotrons is the narrow gap design with the accelerating electrodes confined to the valleys. For intermediate energy cyclotrons the advantages of this design lie in lower cost and in lower r-f power and stored energy, with resulting lower wear and tear on the system. (W.D.M.)

### 13352

Oak Ridge National Lab., Tenn. PRELIMINARY DESIGN OF THE R-F SYSTEM FOR ORIC. R. E. Worsham. p.150-8 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The ORIC is being designed to accelerate protons, deuterons, alphas, and the heavy particles over a continuous energy range. The maximum energy is to be 75 Mev for protons, and the maximum beam current is to be as high as one milliampere. Preliminary design work on the r-f system is discussed in detail. (W.D.M.)

### 13353

[California. Univ.], Berkeley. Lawrence Radiation Lab. SURVEY OF R-F TECHNIQUES APPLICABLE TO VARIABLE-ENERGY CYCLOTRONS. B. H. Smith. p.159-66 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A number of r-f techniques from various cyclotrons are presented which would appear to be useful in the solution of the r-f problems of the new machines. A scheme is reported on which makes use of the change in volume to obtain the change in frequency. At the highest frequency the geometry results in the interleaving of two comb-shaped structures so that the charging currents are spread out over a large area and the resulting power losses are small. The r-f system of the 88-in. cyclotron at Berkeley is described. (W.D.M.)

### 13354

Colorado. Univ., Boulder. THE R-F SYSTEM FOR THE UNIVERSITY OF COLORADO 52-INCH CYCLOTRON. W. R. Smythe. p.167-70 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The University of Colorado cyclotron was conceived as a variable-energy, isochronous machine which would cover the energy region immediately above the electrostatic accelerators. With a maximum  $B_0$  of 7.8 kilogauss-meters, the cyclotron can produce 30-Mev protons and alphas, 15-Mev deuterons, and 40-Mev  $\text{He}^3$ . The r-f system is discussed in some detail. (W.D.M.)

**13355**

Los Alamos Scientific Lab., N. Mex.  
VARIABLE FREQUENCY IN THE LOS ALAMOS CYCLOTRON. Keith Boyer. p.171-3 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The r-f system of the Los Alamos variable energy cyclotron uses a self-excited, tuned-grid tuned-plate oscillator operating with two 880's in push-pull. As a consequence of the flutter-field focusing the radial stability is reduced. This has introduced some problems in the stability of the oscillator. These problems are discussed and the usefulness of an additional stub line in extending the range of frequency variation is pointed out. (W.D.M.)

**13356**

Rochester, N. Y. Univ.  
THE R-F SYSTEM OF THE VARIABLE-ENERGY CYCLOTRON AT THE UNIVERSITY OF ROCHESTER. H. W. Fulbright. p.174-8 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The r-f system of the 26-inch variable-energy cyclotron at the University of Rochester is described. The oscillator is connected to a resonant line with a remotely controlled shorting bar. (W.D.M.)

**13357**

Cambridge [Electron] Accelerator, Mass.  
A PROPOSAL FOR VARYING THE FREQUENCY OF A FIXED-FREQUENCY CYCLOTRON. J. R. Rees. p.179-80 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A proposal for converting the MIT fixed-frequency cyclotron to variable-frequency operation is discussed. The voltage distribution on the dee-line is just the beginning of a sine wave owing to the heavy capacitive loading. If a perturbing dielectric solid (rutile) is put in the line and moved along it, then it moves in a region of ever increasing electric field and increases the local capacitance and in general lowers the frequency. (W.D.M.)

**13358**

Australian National [Univ.], Canberra.  
BEAM DEFINING SLITS AND FOCUSING GRIDS NEAR THE ION SOURCE. W. I. B. Smith. p.183-91 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

An attempt is described to improve beam quality by getting a large beam from the ion source and then stopping most of this beam at slits near the source, in order to accelerate only that beam which one may expect to extract. There is essentially one phase bunching, however good energy bunching is obtained on the first and second half-turns. (W.D.M.)

**13359**

Oak Ridge National Lab., Tenn.  
FACTORS AFFECTING BEAM QUALITY. T. A. Welton. p.192-8 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The major factors affecting beam quality in a cyclotron are considered in general terms. Extraction of a high quality intense beam for injection into a large synchrotron is discussed. (W.D.M.)

**13360**

Philips' (N. V.) Gloeilampenfabrieken. Forschungs-laboratorium, Eindhoven, Netherlands.

THE INFLUENCE OF REGENERATIVE EXTRACTION ON THE ENERGY SPREAD. N. F. Verster. p.199-202 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The question of external beam quality for a 150-Mev synchrocyclotron with an infinitely small dee voltage is considered. The dee voltage is of the order of 20 kv, giving an orbit spacing of less than 0.1 mm, while radial oscillations occur with amplitudes of 2 cm. The particles are deflected by a regenerative deflection system. (W.D.M.)

**13361**

Michigan State Univ., East Lansing.  
BEAM QUALITY MEASUREMENTS AND FOCUSING GRID STUDIES. H. G. Blosser. p.203-7 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Beam quality measurements on the deflected beams of a Cockcroft-Walton and an 86-in. cyclotron are described. A study was also made of the use of electric focusing grids at the center of the cyclotron. (W.D.M.)

**13362**

[California, Univ., Livermore]. Lawrence Radiation Lab.  
LIVERMORE CYCLOTRON BEAM FEATURES. C. J. Taylor. p.208-10 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A plot of the first harmonic found in the magnetic field at one excitation is given. Data taken during the checking of threshold voltage calculations are shown. The beam is given as a function of radius for different dee voltages, where the theoretical threshold voltage was 21 kv. (W.D.M.)

**13363**

Oak Ridge National Lab., Tenn.  
ION SOURCE AND BEAM QUALITY STUDIES. Royce J. Jones. p.211-15 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Ion source studies in connection with the ORIC cyclotron were conducted with the ORNL 44-inch cyclotron, the 63-inch cyclotron, and a d-c ion source test unit. Results and information are given on increasing the ion output of a cyclotron, observing the phase shift and distribution of ion groups, and operation of a d-c source test unit in a 6,400-gauss field. (W.D.M.)

**13364**

Washington, Univ., Seattle.  
BEAM QUALITY FOR NUCLEAR SCATTERING AND REACTION STUDIES. F. H. Schmidt. p.216-19 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The characteristics and quality factors of a cyclotron beam for nuclear scattering and reaction experiments are discussed. (W.D.M.)

**13365**

Rochester, N. Y. Univ.  
BEAM QUALITY AND OPERATIONAL EXPERIENCE WITH THE UNIVERSITY OF ROCHESTER VARIABLE-ENERGY CYCLOTRON. W. P. Alford. p.220-2 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."



The beam handling system and the beam quality of the variable energy cyclotron at the University of Rochester are described. Operating experience with the machine is briefly mentioned. (W.D.M.)

**13366**

Philips's (N. V.) Gloeilampenfabrieken. Forschungs-laboratorium, Eindhoven, Netherlands.

REGENERATIVE BEAM EXTRACTION FROM THE 150-Mev SYNCHROCYCLOTRON AT THE LABORATOIRE CURIE. N. F. Verster. p.224-9 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The development of the regenerative deflection system for the 150-Mev synchrocyclotron at Orsay is described. No beam was available to check the system and a rather careful analysis was necessary. The radial oscillations in the median plane were determined and the axial oscillations of a particle following this radial orbit were calculated. (W.D.M.)

**13367**

[California. Univ.], Livermore. Lawrence Radiation Lab. BEAM EXTRACTION IN THE LIVERMORE CYCLOTRON. J. M. Peterson. p.230-3 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Beam extraction experience with the 90-inch Livermore cyclotron is described. The system is purely electrostatic. The two sectors are mechanically and electrically independent. A measure of the angular spread of the beam as it enters the deflector is obtained. An interesting feature of the deflection system is the use of the cam-shaped magnet pole-face. (W.D.M.)

**13368**

Oak Ridge National Lab., Tenn. BEAM DEFLECTION WITH THE AID OF A NONLINEAR RESONANCE. M. M. Gordon. p.234-40 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

A rather unconventional technique for beam extraction is considered which it is hoped, will be technically well adapted to sector machines. The technique is a modification of the basic regenerative idea wherein use is made of nonlinear resonances that occur in these machines. The nonlinear resonance has the property that it will build up radial oscillation amplitude in the machine at a rapidly accelerated rate, so that one could in principle get a large turn separation from this effect. (W.D.M.)

**13369**

Michigan State Univ., East Lansing. BEAM DEFLECTION SYSTEMS. H. G. Blosser. p.241-5 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Calculations are discussed which are the initial steps in the design of a resonant deflection system for a medium energy cyclotron. The phenomena of "pockets" or "eyes" in the stability region are explained. Preliminary calculations on an electrostatic deflector are reported. (W.D.M.)

**13370**

Oak Ridge National Lab., Tenn. BEAM EXTRACTION STUDIES FOR THE ORIC. Robert H. Bassel. p.246-50 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

Some preliminary studies of the 3/3 resonance, the

"natural" resonance to be used in extracting particles from ORIC, are considered. The original extraction studies for the ORIC were made with raw model magnet data as input for the equilibrium orbit and Welton's general orbit codes. The deviation from the true axial frequency caused by random field errors is shown. (W.D.M.)

**13371**

[California. Univ.], Berkeley. Lawrence Radiation Lab. SOME OBSERVATIONS ON CYCLOTRON SHIELDING. Burton J. Moyer. p. 251-6 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The radiological problems associated with the 88-inch Berkeley cyclotron fall into three categories: escape of radiation and its suppression; activation of parts of the cyclotron; and entry into the shielding enclosure just after shut-down. These problems are discussed in some detail. (W.D.M.)

**13372**

Washington. Univ., Seattle. EXTERNAL BEAM FOCUSING SYSTEM. F. H. Schmidt. p.257-61 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The external beam focusing system of the University of Washington cyclotron is briefly described. The cyclotron ejects the beam through a target chamber, a focusing magnet, then a water-filled shielding room. In the target box and in the shutter box just ahead of the focusing magnet there is a system of remotely adjustable beam delimiting slits. The focusing magnet employs "edge focusing" so that it focuses in both the horizontal and vertical planes. An analyzing magnet directs the beam into one of two scattering chambers. (W.D.M.)

**13373**

Argonne National Lab., Lemont, Ill. EXTERNAL BEAM FOCUSING SYSTEM—ARGONNE 60-INCH CYCLOTRON. Warren J. Ramler. p.266-9 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The external beam of the Argonne 60-inch cyclotron can consist of either deuterons (21.6 Mev), helium ions, or molecular hydrogen ( $H_2^+$ ). The experimental machine requirements have established a range of beam operation from the nominal quoted currents down into the region of  $1 \times 10^{-11}$  amperes. The external beam focusing system is described. (W.D.M.)

**13374**

Los Alamos Scientific Lab., N. Mex. OPERATION OF THE LOS ALAMOS VARIABLE-ENERGY CYCLOTRON. Keith Boyer. p.262-5 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The Los Alamos Variable Energy Cyclotron constitutes a development intermediate between the ordinary low energy cyclotron and the medium energy isochronous machines. Design and relevant operating experience obtained with the machine are discussed. (W.D.M.)

**13375**

Oak Ridge National Lab., Tenn. BEAM FACILITIES PLANNED FOR THE ORIC. Roger S. Bender. p.270-1 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The external optics and facilities for the ORIC are

briefly discussed. Present plans for the machine are shown. (W.D.M.)

### 13376

Illinois. Univ., Urbana.

**MULTI-PURPOSE MAGNETIC PARTICLE ANALYZER.** A. I. Yavin. p.272-88 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1955."

A suggestion is made to apply Mileikowsky's idea of an astigmatic magnet to Enge's spectrometer. The magnet used in Enge's spectrometer should be kept in the perpendicular position when used both as a spectrograph and as a spectrometer. The current in the quadrupole magnet can be adjusted to yield any value of  $d_z - d_r$ . (W.D.M.)

### 13377

Minnesota. Univ., Minneapolis.

**BROADENING BEAMS IN TIME.** R. M. Eisberg. p.289-90 of "Sector-Focused Cyclotrons. Proceedings of an Informal Conference, Sea Island, Georgia, February 2-4, 1959."

The duty cycle of the machine, particularly in a cyclotron, depends on the resolving time. If the experimental equipment has 5 ms resolution, the r-f fine structure is seen, and the effective duty cycle of the machine is just the phase bunching (3 or 4%). The problem of increasing this figure is considered. (W.D.M.)

## Plasma Physics and Thermonuclear Processes

### 13378 AD-201913

Avco Mfg. Corp. Avco Research Lab., Everett, Mass. **MAGNETOHYDRODYNAMIC DISTORTION OF A MAGNETIC FIELD DUE TO A UNIFORM FLOW.** Research Report 29. David S. Falk. Apr. 30, 1958. 7p.

An exact solution is obtained for the distortion of the magnetic field of a straight wire of vanishing diameter, due to the uniform flow of a fluid with constant scalar conductivity, in the limit where the effect of the field on the flow is neglected. The results are presented graphically. (W.D.M.)

### 13379 AD-229802

Douglas Aircraft Co., Inc., Santa Monica, Calif.

**A STUDY OF THE STRUCTURE OF THE MAGNETOHYDRODYNAMIC SWITCH-ON SHOCK IN STEADY PLANE MOTION.** Z. O. Bleviss. Oct. 1959. 38p. (SM-23720).

The structure of the steady magnetohydrodynamic switch-on shock wave is investigated for several order-of-magnitude orderings of the four diffusivities involved in the problem. The various orderings are approximated by allowing one or more of the appropriate diffusivities to approach zero, and approximate solutions that are uniformly valid to order unity are sought. In general, singular perturbation problems are encountered, the number of them depending upon the ordering of the diffusivities and the magnitude of the downstream velocity normal to the shock relative to certain critical velocities downstream of the shock. Where necessary, the approximate solutions are rendered uniformly valid to first order by the insertion of boundary layers, for which the approximate equations are determined to first order. For most of the cases considered, the limiting forms of the integral curves are determined and they are sketched in appropriate three-dimensional phase spaces. (auth)

### 13380 AERE-R-3075

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

**HIGH FREQUENCY PROPERTIES OF A UNIFORM PLASMA. PART II. EFFECT OF A UNIFORM MAGNETIC FIELD.** J. Randles. Oct. 1959. 68p. BIS.

The effect of a uniform magnetic field on the high-frequency motion of a plasma is considered. The response of a magnetized plasma to a forced plane wave is computed and the process of interaction which takes place between the wave and plasma is clarified. The theory of simple plasma oscillations is developed and the dispersion relation for the case when the electron velocity distribution is Maxwellian is derived. A formalism embracing waves with transverse components is developed and equations giving the dispersion relation and structure of the wave are derived. The effect of thermal motion is introduced by considering a plasma in which the magnetic field is relatively small. (W.D.M.)

### 13381 AERE-R-3100

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

**A SIMPLE HYDROMAGNETIC STABILITY PROBLEM INVOLVING FINITE TRANSPORT PROCESSES.** R. J. Tayler. Jan. 1960. 34p. BIS.

An equilibrium configuration is considered which is neutrally stable against all perturbations in the absence of transport processes. The dispersion relation is derived and solved in its entirety and for the cases in which only finite conductivity and viscosity are present. When the electrical conductivity is finite, it is shown that the system is unstable against perturbations of any wavelength. If viscosity alone is finite the system is stable against all perturbations. For the case of infinite conductivity and zero viscosity, the system is shown to be marginally stable against perturbations of all wavelengths. If both viscosity and electrical conductivity are introduced, the system is unstable but the viscosity causes short wavelength instabilities to grow extremely slowly. (C.J.G.)

### 13382 AERL-AMP-36

Avco Corp. Avco-Everett Research Lab., Everett, Mass. **BIBLIOGRAPHY ON MAGNETOHYDRODYNAMICS, PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR PROCESSES.** Barbara A. Spence, comp. Oct. 1959. 101p.

A bibliography is presented as compiled from Physics Abstracts, Nuclear Science Abstracts, Mathematical Reviews, Technical Translations, U. S. Government Research Reports, ASTIA's Technical Abstract Bulletin, reference lists in conference proceedings, publisher's catalogs, publication lists, and journals. An author index is included. 1800 references. (T.R.H.)

### 13383 AFOSR-TN-57-57

**TORSIONAL MAGNETO-HYDRODYNAMIC WAVES IN THE PRESENCE OF FINITE VISCOSITY.** Technical Note No. 1 (Type 2). Edwin Blue. Jan. 1, 1957. 101p. Project No. R-357-50-7. Contract AF18(600)-1041. (AD-115096)

An idealized boundary value problem corresponding to an experiment involving the generation of a system of torsional magnetohydrodynamic waves in liquid sodium in the presence of finite viscosity is considered. The analysis of the solution of the problem led to the formulation and design of "ideal" experiments which would provide suitable tests of the linearized theory. (W.D.M.)



**13384 AFOSR-TN-58-418**

Maryland. Univ., College Park.

THE STRUCTURE OF A HYDROMAGNETIC SHOCK IN STEADY PLANE MOTION. G. S. S. Ludford. Apr. 1958. 20p. Project No. 47500. Contract AF49(638)-154. (BN-131; AD-158221)

The transition solutions (depending on one coordinate  $x$  only) are considered for the equations of steady plane motion of an electrically conducting perfect viscous gas in the presence of a magnetic field in its own plane, on the basis of continuum theory. (auth)

**13385 AFOSR-TN-59-1302**

California Inst. of Tech., Pasadena. Guggenheim Aeronautical Lab.

MAGNETOHYDRODYNAMIC SIMPLE WAVES. J. D. Cole and Y. M. Lynn. Dec. 1959. 54p. Contract AF49(638)-476.

The simple wave solutions, which in ordinary gas dynamics correspond to expansion flows or Prandtl-Meyer flows are generalized to ideal magnetohydrodynamic flows. The one-dimensional unsteady  $(x,t)$  case is considered. Due to magnetic effects more than one component of field and velocity must be considered. To carry out the simple wave formalism the equations of motion (continuity, momentum, induction) are written in terms of flow velocities  $(u_1, u_2)$ , Alfvén velocities  $(b_1, b_2)$  and sound speed  $(a)$ . These velocities are then functions only of the phase  $\xi = x_1 - U(\xi)t$ ; each phase line can be thought of as an infinitesimal wave propagating with a speed  $c = U - u_1$  related to the flow. By elimination of  $(u_1, u_2)$  the system of five first-order ordinary differential equations can be reduced to three (homogeneous) equations. The vanishing of the determinant of coefficients provides a famous relation for wave speed  $c$  and reduces the problem to integration of two first-order equations. The further introduction of dimensionless variables, ratios of wave speeds, reduces the problem to integration of a single first-order equation. By studying the trajectories of this differential equation an overall view of all possible solutions is obtained; numerical integration is also carried out in the case of slow waves. As applications of this theory various physical problems are studied, the receding piston and waves produced by a current sheet. (auth)

**13386 MATT-Q-9**

Princeton Univ., N. J. Project Matterhorn.

QUARTERLY REPORT COVERING THE PERIOD OCTOBER 1-DECEMBER 31, 1959. Jan. 1960. 37p. Contract AT(30-1)-1238. OTS.

A significant reduction in impurity level during ohmic heating was obtained with the B-3 stellarator. As part of the general program of impurity reduction discussed previously, the injected hydrogen was purified with a palladium leak, and discharges at the rate of one per second for 12 hours were used to clean the tube. With this technique the number of carbon atoms in the plasma during ohmic heating was reduced to one fifth the previous value, and now amounts to about 0.5 per cent of the number of hydrogen atoms present initially in the tube. The gross properties of the discharge are somewhat altered and appear somewhat more reproducible. It is hoped that with further reduction in the impurity level, with use of a mercury pumping system, vacuum melted stainless steel, and a divertor, the plasma will remain hot for substantial periods after ohmic heating is over. An auxiliary result from this work, of great practical importance for the entire experimental program, is that the present level of

relatively high purity can apparently be achieved by discharge clean-up alone, without baking, after the vessel has been opened to air. Measures of the oscillations in B-1 indicate that for the  $m = 3$  mode as well as for the  $m = 1$  mode the observed variations of light, magnetic field, and electron density are entirely due to plasma rotation. Potential measurements with a Langmuir probe show that when the current is outside the critical ranges for all the lower modes, the plasma potential falls nearly to zero, indicating that the rotation ceases under these conditions. Measures with a magnetic probe on B-65 verify that ion-cyclotron waves propagate out from the heating section with relatively little damping. Moreover, the waves appear to penetrate to the center of the plasma with little change in amplitude. These results tend to confirm hopes that this technique should be an effective way of heating a plasma. Fabrication of components for Stage 1 operation of Model C now appears to be consistent with a revised schedule, according to which the device will be ready for system tests late in 1960. (For preceding period see MATT-Q-8.) (W.D.M.)

**13387 NP-8501**

Massachusetts Inst. of Tech., Cambridge. Naval Supersonic Lab.

A MICROSCOPIC ANALYSIS OF MAGNETO-GAS-DYNAMICS. Technical Report 395. Eugene E. Covert. [1959]. 50p.

Presented at the Third Biennial Gas Dynamics Symposium held under the auspices of the Hydromagnetics Committee of the American Rocket Society and the Gas Dynamics Laboratory of Northwestern University at Northwestern University, Evanston, Ill., on August 24, 25, and 26, 1959.

The kinetic theory approach to magneto-gas-dynamics is discussed. The several methods of considering interactions, in which the long range forces are of importance, are compared critically. In particular, the effects of the magnetic field on the particle interactions and their trajectories are shown to introduce anisotropies in magneto-gas-dynamics. The effects of these anisotropies are briefly discussed. (auth)

**13388 ORNL-2710**

Oak Ridge National Lab., Tenn.

ELECTRODE BREAKDOWN AND SHIELDING OF INTENSE DISCHARGES ACROSS THE MAGNETIC FIELD. J. W. Flowers. Apr. 13, 1960. 20p. Contract W-7405-eng-26. OTS.

PIG discharges were operated in a uniform magnetic field of 5000 gauss and over a path length of 6 feet with currents ranging from 5 to 180 amperes for argon. Electrode failure, initially encountered, required the development of improved electrode shields which enabled grading of potentials near the electrodes. Potential distribution possibly afforded by multiple shields in a plasma-magnetic field environment is discussed in relation to plasma conductivity transverse to the magnetic field. An anode breakdown condition was attained at high power of operation and provided a limit of the gas discharge for the anode position and dimensions. (auth)

**13389 TID-5701**

Stevens Inst. of Tech., Hoboken, N. J.

MAGNETIC COMPRESSIONAL HEATING AND CUSP CONFINEMENT OF A PLASMA. G. Schmidt, D. Finkelstein, S. Koslov, and K. C. Rogers. [1959]. 16p. OTS.

A new concept for producing a high-temperature plasma and confining it in a stable cusp configuration is described. The plasma is heated inside two coaxial collapse type coils with opposing fields, then two "Magnetic Throttles" open

the way for the plasma into the central region where a stable cusp configuration is established. It is shown that during the transition from the cylindrical to the cusp configuration the plasma receives additional energy from the magnetic field. (auth)

### 13390 JPRS-2391

THE DISTRIBUTION FUNCTION OF ELECTRONS IN A PLASMA SITUATED IN A MAGNETIC FIELD. V. S. Kudryavtsev. Translated from p.114-20, Vol. III, of "Fizika Plazmy i Problema Upravlyaemykh Termoyadernykh Reaktsii." 8p. OTS.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, as abstract No. 6572.

### 13391

A METHOD OF SOLUTION OF THE EQUATIONS OF MAGNETOHYDRODYNAMICS. Judith Blankfield and G. C. McVittie (Univ. of Illinois, Urbana). Arch. Rational Mech. and Anal. **2**, 411-22(1958-59). (In English)

A method for the solution of the two groups of magnetohydrodynamic equations is presented. The derivations and explanations of the equations for these groups are explained. A particular solution of the equations of magnetohydrodynamics was obtained describing the motion of a gas cloud with finite plane faces normal to the direction of motion, the forces being the pressure gradient and a magnetic force parallel to the faces. (B.O.G.)

### 13392

STUDY OF A PLASMA COLUMN CONTINUOUSLY FED AND EXPOSED TO AN ELECTROMAGNETIC FIELD: CONDITIONS OF EXISTENCE OF NON-CENTERED MAXWELLIAN SOLUTIONS: EQUATIONS FOR DENSITIES. Jean-Michel Dolique. Compt. rend. **250**, 1221-2 (1960) Feb. 15. (In French)

A cylindrical column of binary plasma, completely ionized, is exposed to the action of constant, axial, externally-applied electromagnetic fields which are uniform outside the plasma. The plasma is characterized geometrically by the density which has two components, the electron density and the ion density. The density equations are established from utilization of the Fokker-Planck equations. Non-centered Maxwellian solutions are found for the equations. (J.S.R.)

### 13393

MEASUREMENT OF THE ELECTRON DENSITY OF AN EVOLVING PLASMA. THE EXPERIMENTAL ARRANGEMENTS. Terenzio Consoli and Michel Dagal. Compt. rend. **250**, 1223-5(1960) Feb. 15. (In French)

Experimental apparatus is described which permits the measurement of the electron density of an evolving plasma in the interval from  $10^{16}$  electrons/m<sup>3</sup> to  $10^{20}$  electrons/m<sup>3</sup>. A measurement of the rotation of the polarization plane is made by the measurement of the dephasing which the two circular incident vibrations make with respect to each other in crossing the medium. The apparatus consists of two functional units: a hyperfrequency unit and a frequency converter unit. The units are shown schematically, and a system is also shown for studying separately the propagation of the two left or right favored vibrations. (J.S.R.)

### 13394

STUDY OF A PLASMA COLUMN FED CONTINUOUSLY AND EXPOSED TO A MAGNETIC FIELD: APPROXIMATION OF THE FIRST ORDER WITH RESPECT TO THE DIFFUSION VELOCITIES: EVIDENCE OF A BOUNDARY ZONE. Jean-Michel Dolique and Michel-Yves Bernard. Compt. rend. **250**, 1458-9(1960) Feb. 22. (In French)

In a preceding report (Compt. rend. **250**, 1221(1960)), it was shown how it is possible to obtain the general equations for electron and neutron densities. A first-order approximation in  $v$ , the diffusion velocity, is developed. (tr-auth)

### 13395

A RELATIONSHIP BETWEEN SOME MAGNETODYNAMIC DISCHARGES OF FLUIDS AND THOSE OF GAS DYNAMICS. Roger Peyret. Compt. rend. **250**, 1871-3(1960) Mar. 14. (In French)

By introducing a relationship between the quantities characterizing a given fluid and that of a fictive fluid, it is shown that the equations governing magnetodynamic discharges of the given fluid are reduced to that of gas dynamics for the fictive fluid. It is also shown that the discharge is continuous when there is shock. (tr-auth)

### 13396

MOBILITY OF HYDROGEN AND DEUTERIUM POSITIVE IONS IN THEIR PARENT GASES. D. J. Rose (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys. **31**, 643-5(1960) Apr.

The mobilities of positive ions in H<sub>2</sub> and D<sub>2</sub> have been measured, using a pulsed Townsend technique. For hydrogen, the mobility  $\mu_0$  corrected to 0°C was 11.8 (cm<sup>2</sup>/v × sec) at E/p<sub>0</sub> = 26(v/sec × mm Hg), increasing to a maximum of 15.3 at E/p<sub>0</sub> = 48, then decreasing to 11.6 at E/p<sub>0</sub> = 150. For deuterium, the mobility was about 0.75 the value for hydrogen throughout the range of E/p<sub>0</sub>. The experiment was performed with uranium-purified gas in an ultra-high vacuum system. Ions were not identified as atomic, diatomic, or triatomic; there was no conclusive evidence of more than one ion at any value of E/p<sub>0</sub>. The H<sub>2</sub> mobility data are significantly lower than those attributed to Mitchell in the range 20 < E/p<sub>0</sub> < 40, and lower than the value ≈12.5 for zero-field mobility generally reported. (auth)

### 13397

CORRELATION BETWEEN CERTAIN EXTINCTION BANDS OF SOLIDS AND PLASMA RESONANCE. B. R. Gossick (Arizona State Univ., Tempe). J. Appl. Phys. **31**, 650-1 (1960) Apr.

A correlation is reported between certain optical extinction bands in sapphire, quartz, the silver and alkali halides, and the calculated plasma resonance of electrons in colloidal particles which are either known or expected to be present. This correlation suggests not only that pile neutrons produce lithium particles in lithium fluoride, but aluminum particles in sapphire, and silicon particles in quartz. (auth)

### 13398

EFFICIENCY OF THE PLASMA THERMOCOUPLE. H. W. Lewis and J. R. Reitz (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys. **31**, 723-7(1960) Apr.

The efficiency of a thermionic converter containing cesium ions is calculated for the regime, in which the plasma density is sufficiently high so that the random current density,  $ne\bar{v}/4$ , is large compared to the actual current density. Under these circumstances, positive space charge barriers are set up at the electrodes, and the plasma region is many free paths in length. The output voltage  $V$  is determined for various currents by a consistent solution of the electrical and thermal conduction problems. The efficiency of the thermocouple is then deduced from the calculated current-voltage characteristic and the appropriate electron temperature distribution. Overall efficiencies up to 32% are predicted for a typical thermocouple circuit. (auth)



## 13399

PLASMA CONTAINMENT BY r.f. AND d.c. FIELD COMBINATIONS. D. G. Dow (California Inst. of Tech., Pasadena) and R. C. Knechtli (Hughes Research Labs., Culver City, Calif.). J. Electronics and Control (1) 7, 316-43(1959) Oct. (In English)

An investigation was made of the use of r-f fields for the containment of hot, dense plasmas, such as those needed for controlled thermonuclear fusion. Because high losses due to skin effect are associated to r-f fields, they will be used at the lowest possible frequency, and only where they constitute a useful supplement to the cheaper d-c fields. Such r-f fields are to be useful for reducing the plasma leakage present in most d-c confinement systems, and to prevent some of the inherent instabilities. One particular combination of d-c and r-f fields was analyzed in detail. It consists of a homogeneous axial d-c magnetic field (or a d-c mirror field) containing a plasma column against radial diffusion; the ends of the column are 'sealed' by means of r-f fields. By using the proper polarization of the r-f fields, it is shown that appreciable plasma pressures can be contained with frequencies as low as a few megacycles. By using r-f powers of the order of a few kilowatts, it is expected to be feasible to contain plasmas of a density exceeding  $10^{14}$  charges/cm<sup>3</sup> at temperatures exceeding 10 ev. (auth)

## 13400

ON THE FLOW OF A CONDUCTING FLUID PAST A MAGNETIZED SPHERE. G. S. S. Ludford (Univ. of Maryland, College Park) and J. D. Murray (Harvard Univ., Cambridge, Mass.). J. Fluid Mech. 7, 516-28(1960) Apr.

In the steady flow of an incompressible, nonviscous, conducting fluid past a magnetized sphere, the first-order effects of the magnetic field and the conductivity are studied. Paraboloidal wakes of vorticity and magnetic intensity are formed, the former being half the size of the latter. The vorticity, generated by the non-conservative electromagnetic force, is logarithmically infinite on the sphere. For the case of a dipole of moment  $M$  at the center of a sphere of radius  $a$ , the drag coefficient is  $C_D = [144\mu^2/5(2\mu + \mu')^2]\beta R_M$ , where  $\mu$  and  $\mu'$  are the permeabilities of the fluid and sphere respectively,  $\beta$  is the ratio of the representative magnetic pressure  $\mu M^2/2a^6$  to the free-stream dynamic pressure, and  $R_M$  is the magnetic Reynolds number. (auth)

## 13401

LARGE AMPLITUDE WAVES IN A COLLISION-FREE PLASMA. I. SINGLE PULSES WITH ISOTROPIC PRESURE. A. Baños, Jr. and R. Vernon (Univ. of California, Los Angeles). Nuovo cimento (10) 15, 269-88(1960) Jan. 16. (In English)

An infinite expanse of low density, fully ionized plasma, magnetically immobilized in a constant and uniform field of magnetic induction is considered. In the absence of collisions it is assumed that the ion and electron motions take place in planes perpendicular to the magnetic field. Transformation is made to a "shock" frame of reference moving at constant speed at right angles to the magnetic field, and a search is made for the class of non-trivial, time-independent, one-dimensional, self-consistent solutions of the Maxwellian set and of the equations of motion of the charged particles; that is, the propagation of transverse pulses and waves whose characteristic length is much smaller than the collision mean free path is studied. Upon making appropriate simplifications, evolved is a system of equations in which collisions are neglected, charge neutrality is assumed, and both ions and electrons behave like

two-dimensional fluids obeying isentropic relations with  $\gamma = 2$  and exhibiting rigorously isotropic pressure tensors. With these simplifications and assumptions, the system of equations can be solved completely by a simple numerical quadrature. Both symmetric pulses and periodic waves are obtained, with characteristic lengths of the order of the plasma "skin depth", or mean gyromagnetic radius for particles traveling with the Alfvén speed. In Part I, is described the solitary pulses, which are the only solutions satisfying the conditions of the undisturbed plasma ahead of the wave train. Two basic parameters are required for a complete specification of the problem: the Alfvén Mach number  $\alpha$ , which gives a measure of the speed of propagation, and the ratio  $\beta$  of the total plasma pressure to the magnetic pressure, which specifies the initial state of the plasma. It is shown that, for given  $\beta$ , stationary solutions exist only for a limited range of speeds  $\alpha$ . (auth)

## 13402

PLASMA TRAPPING IN CUSPED GEOMETRIES. Harold Grad (New York Univ., New York). Phys. Rev. Letters 4, 222-3(1960) Mar. 1.

The mechanism for trapping of a single particle (a low- $\beta$  stream) in a two-dimensional cusped configuration is considered. The analysis is extended to the case of axial injection through a point cusp in a three-dimensional geometry. The problem of computing the trapping of a high- $\beta$  plasma burst which can alter the magnetic field is discussed. (C.J.G.)

## 13403

ON INITIAL CONDITIONS IN HYDROMAGNETICS. G. S. S. Ludford (Harvard Univ., Cambridge, Mass.). Proc. Cambridge Phil. Soc. 55, 141-3(1959) Jan.

The basic equations governing the motion of an electrically conducting inviscid gas without thermal conductivity are given. Equations are derived which describe completely the character of the initial relaxation period for good conductors. It is noted that the appropriate initial conditions for a perfect fluid conductor without displacement currents and charge accumulation do not depend on the order of the  $\epsilon \rightarrow 0$  and  $\sigma \rightarrow \infty$  limits. (B.O.G.)

## 13404

THE PINCH EFFECT. S. Kumar Trehan (Univ. of California, Berkeley). Rev. mex. fis. 8, 255-72(1959). (In English)

A review of some recent work on the effect of magnetic constriction in gaseous plasmas is presented. After a general discussion of the phenomenon, the criteria for the establishment of a pinched plasma column is obtained from the Marshall and Rosenbluth formalism. (tr-auth)

## 13405

VARIATIONAL PRINCIPLE IN MAGNETIC HYDRODYNAMICS. R. V. Polovin and I. O. Akhiezer (Inst. of Physics and Technology, Academy of Sciences, Ukrainian SSR). Ukrain. Fiz. Zhur. 4, 677-8(1959) Sept.-Oct. (In Ukrainian)

The equation of motion in magnetohydrodynamics was derived using the variation principle and variations in Lagrange functions. (R.V.J.)

## 13406

MAGNETOSONIC WAVES IN RAREFIED PLASMA. K. M. Stepanov. Ukrain. Fiz. Zhur. 4, 678-9(1959) Sept.-Oct. (In Ukrainian)

Attenuation of magnetosonic waves in rarefied plasma is calculated using the thermal motion of electrons and ions in plasma based on kinetic interactions. (R.V.J.)

## 13407

SYMPOSIUM OF PLASMA DYNAMICS. Francis H. Clauser, ed. Reading, Mass., Addison-Wesley Publishing Company, Inc., 1960. 377p. \$12.50.

Papers and discussions from the symposium on plasma dynamics held at Woods Hole, Massachusetts, in 1958 are presented. Problems in generating, heating, and confinement of plasmas are discussed. The behavior of highly ionized plasmas is described. The dynamics of electron beams is discussed. Explanations and applications of statistical plasma mechanics are presented. The analysis of a plasma and its properties by continuum dynamics is discussed. Theories on solar, planetary, and interplanetary flight and cosmical magnetohydrodynamics are contained. (C.J.G.)

## Shielding Calculations

## 13408 WAPD-TM-193

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

CALCULATION OF THERMAL NEUTRON FLUXES IN PRIMARY SHIELDS. D. C. Anderson and K. Shure. Nov. 1959. 44p. Contract AT-11-1-GEN-14. OTS.

A method is presented for calculating thermal neutron fluxes in the primary shields of reactor systems which eliminates reliance on mock-up experimental data. A multigroup  $P_1$  approach is employed with the spatial dependence of the neutron attenuation adjusted through use of a point source attenuation kernel for a homogeneous hydrogenous medium. Comparison of calculation with experiment is presented. (auth)

## 13409

CALIBRATION OF ORNL LID-TANK FISSION PLATES. Whittle J. McCool (Pratt and Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.) and D. R. Otis (Convair, San Diego, Calif.). *Nucleonics* 18, No. 4, 98; 100; 122-3 (1960) Apr.

The SP-2 fission plate in the ORNL Lid Tank Shielding Facility was calibrated on three occasions and these data were used for a retrospective recalibration of SP-1, whose nonuniform geometry made its original calibration suspect. The three independent calibration experiments performed to determine the fission rate in SP-2 were: thermal-neutron flux and utilization; neutron-generation rate; and heat-generation rate. A weighted average of these methods gives a fission rate of  $1.62 \times 10'' \pm 5\%$  fissions/sec of equivalent to  $5.18 \pm 5\%$  watts of reactor power. The weighted average effective source strengths of LTSF fission plates are 1.7 and 1.14 watts for neutrons and gammas in SP-1 and 4.87 and 4.56 watts in SP-2. The large difference in the effective power of SP-1 is attributed to excessive self-absorption of gammas by the thick SP-1 components. (B.O.G.)

## Theoretical Physics

## 13410 AFOSR-TN-60-276

Cambridge Univ., England.

PHYSICAL LIMITATIONS TO DISPERSION RELATIONS. Technical Scientific Note No. 3. John G. Taylor. Jan. 1960. 23p. Contract AF61(052)-233.

Limitations to the validity of dispersion relations arising in the general proof of these relations are discussed by considering fourth order perturbation theory. The exchange scattering of equal mass bosons or nucleons gives

a limitation to the general proof, but closer analysis shows this limitation can be removed. The direct scattering term gives no limitation when anomalous thresholds are absent, but when they are present shows that the general proof cannot be applied to this case. A direct analysis in this latter case shows that the dispersion relations are not violated for any momentum transfer, though the two-dimensional representation is. (auth)

## 13411 AFOSR-TN-60-307

Weizmann Inst. of Science, Rehovoth, Israel.

ON A MODIFIED BETHE-GOLDSTONE EQUATION. Technical Note No. 1. Amnon Katz. Feb. 1, 1960. 38p. Contract AF61(052)-337.

A many fermion system with Bardeen, Cooper, and Schieffer interaction is treated by a modified BG equation which takes into account a self consistent spreading of the Fermi surface. The method employs a modified wave function which is an eigenstate of one modified hamiltonian and from which energies are determined by another. Pairs with total momentum zero are treated as elementary entities. All modifications are achieved by a "projection operator" which *a priori* takes care of the interference between pairs due to their statistics. The only case solved is the one where all interacting pairs go into the Cooper state of the modified hamiltonian. The results are identical with those of BCS. (auth)

## 13412 LAMS-1718

Los Alamos Scientific Lab., N. Mex.

KINEMATICS OF THE RELATIVISTIC TWO-BODY PROBLEM. Leroy Blumberg and Stewart I. Schlesinger. Aug. 1955. 85p. OTS.

The kinematics of elastic scattering, inelastic scattering, and the two body reaction problem is developed in the relativistic limit. Exact expressions were obtained for the energies, angles, and solid-angle transformations involved. The results are specialized for zero rest mass of one or more of the particles involved. An outline for the coding of the problem on the IBM-701 is presented. (auth)

## 13413 NP-8561

Joint Inst. for Nuclear Research, Dubna, U.S.S.R.

FLUCTUATIONS OF SPACE-TIME METRIC. D. I. Blokhintsev. 1960. 9p. (D-474).

Fluctuations of the metric tensor were analyzed for the two cases: (1) in the macroworld where the fluctuations are due to the turbulent motion of matter; and (2) in the microworld where the fluctuations are caused by zero vacuum oscillation. For the latter case it was shown that these fluctuations are essential for distances on the order of  $\sim 10^{-32}$ . (C.J.G.)

## 13414 TID-5773

Washington. Univ., Seattle.

SELECTED TOPICS IN THE QUANTUM STATISTICS OF INTERACTING PARTICLES. Lectures given at the Dept. of Physics, Univ. of Washington. Leon Van Hove. Lecture notes prepared by H. Richard Blieden, Timothy G. Kelley, and Victor A. Madsen. 1958. 149p. OTS.

Quantum statistical aspects of the anharmonic crystal in equilibrium, the approach to equilibrium, and the zero temperature properties of a conduction electron in a crystal lattice are treated. A description of the Bravais lattice without imperfections is given. The reduction of the harmonic part of H to normal modes is demonstrated. The quantum mechanical problem of the harmonic crystal is investigated, including the effect of the anharmonic terms. Calculations of the free energy of a crystal, the low-temperature limit, and other macroscopic quantities and



microscopic averages were made. The development of a Hamiltonian for studying the equilibrium of a system composed of electrons in an insulating crystal is discussed. A rough calculation of  $B'$ , the interaction constant, is presented. The physical effects of the interaction of one electron with the photon gas are described. Diagram calculations for the partition function are presented and partial summation of diagrams is discussed. A mathematical description of the dissipation process is given, including derivation of the master equation which refers to states of the entire system. The Boltzmann equation for governing the momentum distribution of the electron as a function of time is derived. The effects of virtual emission in the electron-photon interactions were studied. (C.J.G.)

### 13415

ON EXPERIMENTAL TESTS OF THE GENERAL THEORY OF RELATIVITY. L. I. Schiff (Stanford Univ., Calif.). *Am. J. Phys.* 28, 340-3(1960) Apr.

Explored is the extent to which the three "crucial tests" support the full structure of the general theory of relativity, and do not merely verify the equivalence principle and the special theory of relativity, which are well established by other experimental evidence. It is shown how the first-order changes in the periods of identically constructed clocks and the lengths of identically constructed measuring rods can be found without using general relativity, and how the red shift and the deflection of light can be computed from them. Only the planetary orbit precession provides a real test of general relativity. Terrestrial or satellite experiments that would go beyond supplying corroborative evidence for the equivalence principle and special relativity would be extremely difficult to perform, and would, for example, require a frequency standard with an accuracy somewhat better than one part in  $10^{18}$ . (auth)

### 13416

MOMENTUM AND CONSERVATION LAWS IN NEWTONIAN AND CANONICAL FORMALISMS. William Frank and George L. Trigg (Brookhaven National Lab., Upton, N. Y.). *Am. J. Phys.* 28, 315-16(1960) Apr.

A simple example is given to show how confusion can result from an uncritical transfer of concepts between Newtonian and canonical (Lagrangian or Hamiltonian) formalisms. (auth)

### 13417

CERTAIN MATTERS IN RELATION TO THE RESTRICTED THEORY OF RELATIVITY, WITH SPECIAL REFERENCE TO THE CLOCK PARADOX AND THE PARADOX OF THE IDENTICAL TWINS. II. DISCUSSION OF THE PROBLEM OF THE IDENTICAL TWINS. W. F. G. Swann (Franklin Inst., Swarthmore, Penna.). *Am. J. Phys.* 28, 319-23(1960) Apr.

The problem of the "twins" concerns two twins a and b. With a at rest in S, set b in motion, allow it to travel a certain distance, and then reverse the motion so that it returns to rejoin a. In this problem, acts are performed on b while nothing is done to a. The problem of the effects of imparting motion to an entity is analyzed in the light of the discussion in Part I, and the customary conclusion is established to the effect that, as measured by heartbeats, b ends the journey younger than a. The customary argument which produces the apparent paradox is to the effect that if we take our stand with b in  $S'$ , we see a moving away from b, then reversing its velocity with subsequent return to b, to find that it, a, is now younger than b. It is pointed out that in this second view of the problem there is danger of envisaging a situation entirely

different from that of the first problem. The danger lies in supposing that in the frame which accompanies b something is done to a—in the reversal of its velocity. The second view of the matter should recognize that to secure the apparent reversal of velocity of a as seen by b, nothing should be done to a from the frame of b, but something should be done to b from the frame of b itself. If the discussion is carried out in this manner, no paradox results. (auth)

### 13418

EÖTVÖS EXPERIMENT AND THE GRAVITATIONAL RED SHIFT. R. H. Dicke (Princeton Univ., N. J.). *Am. J. Phys.* 28, 344-7(1960) Apr.

The relation of the results of the Eötvös experiment to the equivalence principle is discussed. It is asserted that the equivalence principle is not established by the results of the Eötvös experiment. The type of discrepancy discussed could result in an anomalous gravitational red shift. Consequently, contrary to the conclusion of L. Schiff [*Am. J. Phys.* 28, 340(1960), this issue], red shift experiments are considered important. (auth)

### 13419

SOME RECENT DEVELOPMENTS IN THE MANY-BODY PROBLEM. D. Ter Haar (Magdalen Coll., Oxford). *Contemporary Phys.* 1, 112-33(1959) Dec.

Reasons are given why the many-body problem has recently become the subject of a rapidly expanding literature. After a survey of the main ideas of recent theories, it is shown how these ideas have played a role in giving a better understanding of such topics as superconductivity, plasmas, and liquid helium. In the theory of the many-body problem the main branches of theoretical physics applied are Hamiltonian mechanics or quantum mechanics (to describe the motion of the constituent particles of the many-body system under consideration) and statistical mechanics (to describe the collective action of the large number of particles in the system). The main concepts of Hamiltonian mechanics and some of those of quantum statistics, including the definition and some of the properties of fermions and bosons, are discussed in an appendix. (auth)

### 13420

A REMARK ON BOPP-PODOLSKII ELECTRODYNAMICS. J. Kvasnica (Inst. of Technical and Nuclear Physics, Prague). *Czechoslov. J. Phys.* 10, 81-90(1960). (In Russian)

A description of the electromagnetic field in vacuum as a specific bi-field, formed by the vectors  $E$ ,  $B$ , and  $H$ ,  $D$ , leads, on the assumption of non-local relation between the components of the bi-field, to electrodynamics of the type  $L(\square) \square A_\mu = -j_\mu$ , where  $L(\square)$  is a rational function of  $\square$ . The scattering of electrons in a Bopp-Podolsky field of force was studied and compared with the results of Hoffstadter experiments. Close connection was shown between electrodynamics with higher derivatives and the results and methods of modern quantum electrodynamics (polarization of electron-positron vacuum, Pauli-Villars regularization). (auth)

### 13421

GAUGE PROPERTIES OF PROPAGATORS IN QUANTUM ELECTRODYNAMICS. Bruno Zumino (Univ. of California, Berkeley). *J. Mathematical Phys.* 1, 1-7(1960) Jan.-Feb.

The effect of a change of gauge on the propagators is studied systematically for quantum electrodynamics. Various gauges are considered, among them the Coulomb, the Landau, the Feynman, and the Yennie gauges. The equiva-

lence of the various formulations of the theory is demonstrated. For the relativistic gages, the transformation of the wave function renormalization constant is described.

(auth)

#### 13422

ON A METHOD OF FINDING SINGULARITIES OF FEYNMAN GRAPHS. L. B. Okun and A. P. Rudik (Inst. of Theoretical and Experimental Physics, Academy of Sciences, Moscow). *Nuclear Phys.* **15**, 261-88(1960) Feb. (2). (In English)

The method of finding the singularities of Feynman graphs suggested by Landau is investigated. Techniques are evolved to establish whether any Feynman graph has a singularity. The method under discussion makes it easily possible to determine its location. To illustrate possibilities of the method the singularities of baryon form-factors and the nearest singularities of some simple scattering amplitudes are determined. (auth)

#### 13423

ON THE CONSTRUCTION OF THE S MATRIX FOR DRESSED PARTICLES. Yu. Novozhilov (Leningrad State Univ.). *Nuclear Phys.* **15**, 469-79(1960) Mar. (1). (In English)

The problem of setting up the S matrix for dressed particles is considered by representing the unperturbed states of the dressed particles by means of asymptotic states and by assuming an exponential structure of the vacuum state. Auxiliary independent fields are introduced to describe dressed particles and the scattering theory is formulated in terms of operators and state vectors in the auxiliary field space. The energy operator in the auxiliary field space (effective Hamiltonian) is divided into two parts: the "free" Hamiltonian, whose eigenstates include states of non-interacting dressed particles, and the interaction operator which specifies the particle interaction (but not interaction between the fields). (auth)

#### 13424

THEORY OF  $K^+$ -NUCLEON SCATTERING. I. R. Gatland (Imperial Coll. of Science and Tech., London). *Nuclear Phys.* **15**, 480-5(1960) Mar. (1). (In English)

Dispersion relations for the K-N interaction show that the "Born" term is dominant in  $K^+$ -p scattering. Calculations are made of the cross section and angular distribution for  $K^+$ -p scattering by perturbation theory using the lowest order Feynman graphs and, given certain parities and coupling constants, this fits the experimental data. The theory does not give good results for  $K^+$ -n scattering. (auth)

#### 13425

A NOTE ON DISPERSION RELATIONS. Alladi Ramakrishnan, N. R. Ranganathan, and R. Vasudevan (Univ. of Madras) and S. K. Srinivasan (Indian Inst. of Tech., Madras). *Nuclear Phys.* **15**, 516-18(1960) Mar. (1). (In English)

Dispersion theory is examined on the basis of a reciprocal relationship between the real and imaginary part of the scattering amplitude and it is shown that the knowledge of the absorptive part over the unphysical region leads to a linear integral equation for the dispersive part. (auth)

#### 13426

ON THE REDUCTION FORMULAE FOR THE S-MATRIX ELEMENTS. J. Hilgevoord (Univ. of Amsterdam). *Nuclear Phys.* **15**, 657-63(1960) Mar. (2). (In English)

Reduction formulas for the S-matrix elements, given by Lehmann, Symanzik, and Zimmermann, are derived with

particular emphasis on a proper use of the asymptotic condition and on the order of integration. It is stressed that local commutativity is not needed for the derivation of most of these formulas. (auth)

#### 13427

A CLASS OF SIMPLE FIELD THEORIES AND VON NEUMANN'S INFINITE DIRECT PRODUCT SPACES. M. Schwartz (Univ. of Minnesota, Minneapolis and Syracuse Univ., N. Y.). *Nuovo cimento* (10) **15**, 334-50(1960) Feb. 1. (In English)

The fixed scalar Boson field is reanalyzed in an attempt to clarify certain issues raised by Van Hove and Miyake regarding the orthogonality of certain Hilbert spaces. The discussion is generalized to include a more general class of models of which the scalar boson field is a special case. (auth)

#### 13428

NORMALIZATION AND INTERPRETATION OF FEYNMAN AMPLITUDES. H. S. Green (Univ. of Adelaide). *Nuovo cimento* (10) **15**, 416-33(1960) Feb. 1. (In English)

A general method is given for normalizing Feynman amplitudes and using them to calculate expectation values. The method is easily applicable to bound states and composite states. Two applications are considered in detail. The first is the normalization of Bethe-Salpeter amplitudes, where it is found that previously suggested normalization conditions are inadequate. The second is the renormalization of the electron amplitude for first-order self-energy processes, and here a method is suggested for making the self-energy finite. The self-energy is three times the energy of the bare electron in this approximation. (auth)

#### 13429

FIELD METRICS. P. Sen (National Physical Lab., New Delhi, India). *Nuovo cimento* (10) **15**, 513-18(1960) Feb. 16. (In English)

A correlation between the metric along which a field propagates and its commutation relations or Feynman propagation function is postulated and the metrics for the fields whose wave equations are known or the wave equations for the fields whose metrics are known are deduced. The metrics of known fields are seen to have simple quadratic forms which define the interaction terms uniquely and from such metrics the interaction terms for nucleon-meson,  $\beta$  decay, and  $\mu$  decay interactions are derived. (auth)

#### 13430

A GENERALIZATION OF THE FOLDY-WOUTHUYSEN TRANSFORMATION. G. Morpurgo (Università, Florence and Comitato Nazionale per le Ricerche Nucleari, Frascati, Italy). *Nuovo cimento* (10) **15**, 624-40(1960) Feb. 16. (In English)

A method for constructing a unitary operator which transforms the Hamiltonian of a Dirac electron, in the presence of an electric field, into an even Hamiltonian is proposed and discussed. The transformation function and the transformed Hamiltonian are expressed through an operator G which satisfies an operator equation; when the electric field is absent (free particle) the Foldy-Wouthuysen transformation is re-derived, and when the electric field is present and the equation for G is solved in series of  $m^{-1}$ , the Pauli, Darwin, Foldy, Wouthuysen non relativistic Hamiltonian is re-obtained. A method of solution is shown to be possible which converges rapidly and is not restricted to the non relativistic case;



the expansion parameter in this method of solution is  $(1/\text{mc}^2)(e\hbar/\text{mc})E$  for a uniform electric field and  $Ze^2/\hbar c$  for a coulomb potential. Only the case of an electrostatic potential is considered in detail. (auth)

**13431**

MANY-BODY PROBLEM IN QUANTUM STATISTICAL MECHANICS. V. DEGENERATE PHASE IN BOSE-EINSTEIN CONDENSATION. T. D. Lee (Columbia Univ., New York) and C. N. Yang (Inst. for Advanced Study, Princeton, N. J.). *Phys. Rev.* **117**, 897-920(1960) Feb. 15.

The formulation of the author's previous paper is extended so that it becomes applicable in an interacting system in the presence of a Bose-Einstein degeneracy. This extension is carried out by the introduction of an x-ensemble, which enables one to utilize an Ursell-type expansion even in the presence of a Bose-Einstein degeneracy. The variational principle of the previous paper is also extended. It is proved that in the presence of a Bose-Einstein degeneracy, the average occupation number of a single particle state with momentum  $p$  approaches infinity as  $p \rightarrow 0$ . The method is applied to a dilute system of Bose hard spheres. (auth)

**13432**

CONTRIBUTION TO THE ELECTROSTATIC SELF-ENERGY OF A CHARGED LIQUID DROP. W. D. Foland (Univ. of Massachusetts, Amherst). *Phys. Rev.* **117**, 1037-43(1960) Feb. 15.

The electrostatic self-energy of the liquid-drop-model nucleus was divided into two parts, one of which was evaluated. The problems arising due to difficulties in choosing limits of integration—difficulties which occur due to the presence in the integrand of the factor  $r_{12}^{-1}$ —are all contained in the formulation of that part obtained. The evaluation of the other part of the self-energy poses no such limit problems. The shapes considered for the drop were the shapes adopted by a nucleus undergoing symmetric fission. The self-energy is expressed as a multiple-power series in the deformation parameters  $a_n$ . The part of the self-energy calculated is zero through the general seventh-power term. (auth)

**13433**

REPRESENTATION OF STATES IN A FIELD THEORY WITH CANONICAL VARIABLES. F. Coester (State Univ. of Iowa, Iowa City) and R. Haag (Princeton Univ., N. J.). *Phys. Rev.* **117**, 1137-45(1960) Feb. 15.

The properties of a functional representation of states for a self-coupled scalar field theory is investigated. The assumption is made that all states can be generated by applying functionals of the field at a fixed time ( $t = 0$ ) to the vacuum state. It is shown that for the class of models considered the hamiltonian is uniquely determined by the vacuum functional. The calculation of scalar products between states leads to functional integrals. The measure in this integration over function space is also determined by the vacuum state. Two methods for the evaluation of the functional integrals are discussed. The first one reduces the problem in some simple cases to the solution of an eigenvalue problem for a Hilbert-Schmidt kernel plus a finite number of ordinary integrations. The other one gives a perturbation series. (auth)

**13434**

CLASSICAL ELECTRODYNAMIC EQUATIONS OF MOTION WITH RADIATIVE REACTION. Gilbert N. Plass (Ford Motor Co., Newport Beach, Calif.). *Phys. Rev. Letters* **4**, 248-9(1960) Mar. 1.

It is shown that when the proper boundary condition is used to specify the initial acceleration of a charged parti-

cle, nondivergent solutions exist for the electrodynamic equations of motion governing a classical radiating charged particle. (C.J.G.)

**13435**

SHELL EFFECTS IN THE OPTICAL POTENTIAL. Atsushi Sugie (Japan Atomic Research Inst., Tokyo). *Phys. Rev. Letters* **4**, 286-8(1960) Mar. 25.

The disagreements between the observed low-energy neutron scattering data (the strength function  $[\Gamma^2/D]$  and the scattering length  $R'$ ) and the predictions from the conventional optical potential, whose imaginary part ( $W$ ) is independent of the mass number  $A$ , are analyzed. Using the model of Laue and Wandel, the above mentioned discrepancies are explained as shell effects. According to the theory derived,  $W$  for the  $p$  state must be small for  $A \sim 60$  and large for  $A \sim 100$ . (C.J.G.)

**13436**

GREEN FUNCTION METHOD IN QUANTUM-STATISTICS. Hideo Kanazawa and Mitsuo Watabe (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)* **22**, 466-8(1959) Sept. (In English)

An extension is presented of the slightly refined Matsubara method for the computation of the grand partition function for quantum statistical averages. This computation is extended for the case of the electron gas, from which the results of Montroll and Ward are obtained. A slight deviation is used to obtain the so-called "water-melon" approximation of Abe. (B.O.G.)

**13437**

SPECTRUM OF ELEMENTARY EXCITATIONS OF SUPERFLUID FERMI SYSTEMS. I. I. Krush and Yu. V. Tsekhnistrenko (Dnepropetrovsk State Univ., SSR). *Ukrain. Fiz. Zhur.* **4**, 86-92(1959) Sept.-Oct. (In Ukrainian)

A number of problems involving the spectrum of elementary excitations of superfluid Fermi systems were studied by the methods of quantum field theory. A system with direct binary interaction is considered at zero and non-zero temperature, as well as an electron-phonon system at absolute zero. On finding Schwinger's equations for one-particle Greene functions, use was made of the ground state approximation proposed by N. N. Bogoliubov, i.e., a formalism was applied which does not preserve the full number of particles. (auth)

**13438**

MANY-BODY PROBLEM OF A FERMION SYSTEM. [PART] I. Wolfgang Wild (Universität, Heidelberg, Ger.). *Z. Physik* **158**, 322-46(1960). (In German)

The many-body problem of a Fermion system interacting by means of a separable potential, which is not restricted to act only between opposite momenta, is investigated using the Klein-Prange formalism. The ladder approximation is applied including hole-hole scattering and self-energy terms. It is shown, that even if singularities of the Gottfried type are present, the problem may be treated in a fully consistent way. For weak coupling the connection with the theory of superconductivity and recent results of Prange is established. The integral equation for the two point function contains terms, which may be neglected in the weak coupling limit, whose influence for the strong coupling case however has not yet been investigated. (auth)

**REACTOR TECHNOLOGY****General and Miscellaneous****13439 HW-33654**

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

**REACTIVITY EFFECTS RESULTING FROM MELTING HOLLOW FUEL ELEMENTS—EXPERIMENT II.** David D. Lanning and W. P. Stinson. Nov. 3, 1954. Decl. Feb. 24, 1960. 9p. OTS.

A second experiment has been performed in the Hanford Test Pile to study the increase in neutron self shielding which occurs when hollow cylindrical slugs melt and collapse. A description of this experiment is presented together with a method for interpreting the results in terms of pile reactivity in reactors of various lattice configurations. A comparison of this experiment with the previous one is made and an example is given to clarify the methods of interpretation. For the example chosen, the results of this experiment show that this pile would have an inherent safety fuse worth 16% in pile reactivity when the hollow fuel elements melt. (auth)

**13440** HW-60311

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

**IMPROVEMENTS IN WATER TREATMENT FOR ONCE-THROUGH REACTOR COOLING.** R. B. Richman. May 8, 1959. 11p. Contract [AT(45-1)-1350]. OTS.

For presentation at ASTM Meeting, San Francisco, October 11-16, 1959.

A treatment process using organic polymers developed to maintain high-quality water for single-pass reactor cooling is described. Features of design include modification of the conventional rapid sand filter bed to provide a low-pressure loss through the filter bed at high filter flow rates, use of a modified light-scattering microphotometer to obtain accurate and rapid measurements of suspended solids, and addition of minute quantities of organic polymers to improve filtration of coagulated and settled water. (J.R.D.)

**13441** MND-M-1854

Martin Co. Nuclear Div., Baltimore.

**PMZ-1 HAZARDS SUMMARY REPORT.**

Henry Rosenthal. Dec. 1959. 91p. Contract AT(30-1)-2345. OTS.

A hazards report was prepared to permit appraisal of the PMZ-1 zero power tests. Information is included about reactor design and safety, the experimental program, excursion analysis, and hazards evaluation. (J.R.D.)

**13442** NASA-TR-R-36

National Aeronautics and Space Administration. Lewis Research Center, Cleveland.

**TWO-DIMENSIONAL DIFFUSION THEORY ANALYSIS OF REACTIVITY EFFECTS OF A FUEL-PLATE-REMOVAL EXPERIMENT.** Edward R. Gotsky, James P. Cusick, and Donald Bogart. 1959. 17p. GPO.

Effects of fuel plates successively withdrawn from the center fuel element of a seven-by-three core loading at the Oak Ridge Bulk Shielding Facility were evaluated by two-dimensional two-group diffusion calculations performed on the NASA reactor simulator. Two calculation methods were used: (1) The slowing-down properties of the experimental fuel element were represented by infinite media parameters; and (2) the finite size of the experimental fuel element was recognized, and the slowing-down properties of the surrounding core were attributed to this small region. Reasonable agreement existed between experimental and calculated effects. (auth)

**13443** WAPD-BT-17

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

**BETTIS TECHNICAL REVIEW. REACTOR PHYSICS AND**

**MATHEMATICS.** Feb. 1960. 89p. Contract AT-11-1-GEN-14 and appropriate NObs-Contracts. OTS.

Eleven papers are presented on developments in reactor physics and mathematics at Bettis Laboratory. Topics covered include resonance escape probability, fast neutron conversion factors, neutron attenuation kernels, three-dimensional flux distributions, xenon transients, homogeneous blankets, surface to volume activation by resonance neutrons, multigroup cross sections, Boltzmann equation, slowing down of neutrons, and transient response of spatial flux distribution to changes in materials properties. Separate abstracts were prepared for the eleven papers. (W.D.M.)

**13444** WAPD-BT-17(p.1-13)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

**RESONANCE ESCAPE PROBABILITY CALCULATIONS IN NON-UNIFORM LATTICE ARRAYS.** R. S. Wick. 13p.

A condensation of this paper was previously abstracted and appears in NSA, Vol. 13, as abstract No. 17387.

**13445** WAPD-BT-17(p.23-9)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

**THREE-DIMENSIONAL FLUX DISTRIBUTIONS IN A ROD-PROGRAMMED SEED-BLANKET SLAB REACTOR.**

D. H. Jones. 7p.

The design of a seed-blanket power reactor requires the knowledge of three-dimensional flux distributions. Since present three-dimensional diffusion digital computer codes do not provide enough mesh points to describe a large reactor in sufficient detail, a method is outlined for combining a two-dimensional and a one-dimensional flux distribution into a synthesized three-dimensional flux distribution for a seed-blanket reactor. The method applied to a rod-programmed seed-blanket slab reactor and the calculated flux distributions are found to be within reasonable agreement with measured flux distributions. (auth)

**13446** WAPD-BT-17(p.69-83)

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

**TRANSIENT RESPONSE OF THE SPATIAL FLUX DISTRIBUTION IN AN INITIALLY UNIFORM BARE REACTOR TO ARBITRARY NON-UNIFORM CHANGES IN MATERIALS PROPERTIES.** S. Kaplan, S. G. Margolis, and D. R. Harris. 15p.

An analysis of the space time behavior of reactor flux resulting from a disturbance of the nuclear materials properties is described. The analysis is by the method of perturbation theory plus a modal expansion. Relations and curves are presented which give the time dependent response of each mode to the disturbance. (auth)

**13447** NP-tr-415

**THE IMPORTANCE FUNCTION IN REACTOR KINETICS.** H. Grömm and K. H. Höcker. Translated by E. L. Poole (U.K.A.E.A. Atomic Energy Research Establishment) from Z. angew. Phys. 9, 305-13(1957). 32p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, as abstract No. 9486.

**13448** NP-tr-416

**THE PROPAGATION OF INITIATING NEUTRONS IN A HOMOGENEOUS THERMAL REACTOR.** K. H. Höcker and F. Wagner. Translated by E. L. Poole (U.K.A.E.A. Atomic Energy Research Establishment) from Z. angew. Phys. 9, 301-5(1957). 13p. JCL.



The propagation of neutrons from a source in a homogeneous bare thermal reactor is investigated. Calculations of the neutron flux as a function of time, the importance function, the stationary flux distribution, and the weighted neutron content were performed for a slab reactor. (C.J.G.)

**13449**

**SAFETY ROD PROTECTION.** F. J. Schijff. Electrotechniek 37, 352-5(1959). (In Dutch)

The KEMA sub-critical suspension reactor is provided with three safety rods of boron carbide which are suspended from electromagnets. The operation and performance of these safety rods are discussed. (Reactor Centrum Nederland)

**13450**

**SAFETY PROBLEMS OF THE PRESSURIZED WATER REACTOR.** M. Hoyaux. Electrotechniek 37, 456-8 (1959). (In Dutch)

**13451**

**ACTIVITIES IN THE COOLANTS OF REACTORS AND DETECTION OF LEAKS OF FISSION PRODUCTS. [PART] II.** J. Labeyrie (Service of Electrical Construction, Saclay, France). Fóton 1, No. 4, 15-25(1959) Mar. (In Portuguese)

The characteristic activity of reactor coolants is examined. The coolants considered are air, CO<sub>2</sub>, or helium under pressure, light or heavy water, organic liquids, and liquid sodium. The activities acquired by these coolants are described, with special emphasis on corrosion products in water. (J.S.R.)

**13452**

**SYNTHESIS OF REACTOR CONTROL SYSTEMS INCLUDING THE CONSIDERATION OF RADIAL SPATIAL BEHAVIOR.** T. Kagayama (Electrotechnical Lab., [Tokyo]). J. Atomic Energy Soc. Japan 2, 78-88(1960) Feb. (In Japanese)

Because of radial spatial instabilities due to xenon and positive temperature effects, it is proposed that several controllers be set up in each region of the core. Then it becomes convenient to express the control system by a matrix. Because of the symmetric installation of the controllers, the system matrix is symmetric and cyclic, and the unitary transformation can be derived, by which the characteristic equation of the system is invariant. A method of synthesizing feedback systems by plotting a root locus is described. The application of this method to the Calder Hall type reactor is presented. (auth)

**13453**

**ORGANIC MODERATORS AND COOLANTS.** Jiri Teplý and Karel Seidl (Czechoslovak Academy of Sciences, Prague). Jaderná energie 6, 3-8(1960) Jan. (In Czech.)

Problems of using organic moderators and coolants for nuclear reactors are discussed and criteria for the choice of organic materials are presented. Property changes of the compounds caused by radiation and heating are presented. The Organic Moderated Reactor Experiment and the Canadian heavy water moderated power reactor employing an organic coolant are described. (auth)

**13454**

**MATERIALS FOR REACTOR CONTROL DEVICES.** Jaroslav Vrtěl. Jaderná energie 6, 9-15(1960) Jan. (In Czech.)

A discussion is presented on the materials used in reactor control devices, the requirements of these materials, and the properties of the most important absorp-

tion materials (hafnium, rare earth elements, cadmium, and boron). (auth)

**13455**

**LUBRICATING MATERIALS FOR ATOMIC REACTORS.** G. Foldiák. Magyar Tech. 2, No. 4, 4(1958). (Translated from Referat. Zhur. Khim. No. 9, 1959, abstract No. 32844).

A brief exposition is given of the problems originating during the lubrication of atomic reactor components, especially those units which are particularly subject to radiation. Data are submitted on the resistance to radiation by mineral lubricants of different origin and composition (paraffin, aromatic, etc.), on the behavior under reactor conditions of certain synthetic lubricants (octadecylbenzene, polypropylene oxides, silicones), and on consistent lubricants.

**13456**

**GAS CONTENT OF GRAPHITES.** J. P. Redmond and P. L. Walker, Jr. (Pennsylvania State Univ., University Park). Nature 186, 72-4(1960) Apr. 2.

Measurements of the gases released from typical nuclear graphites when degassed at 1500 to 2000°C in vacuo were made. The results are compared to those obtained with an electrode graphite subjected to the same conditions. (C.J.G.)

**13457**

**TRENDS IN FRENCH REACTOR INSTRUMENTATION.** M. Surdin, ed. (Commissariat à l'Énergie Atomique, Paris). Nuclear Power 5, No. 48, 124-6(1960) Apr.

A survey is presented of the trends in French reactor instrumentation which shows continuing interest in miniaturization. The discussion includes instrumentation for reactor control, the processing of health physics measurements, and the detection of burst slugs. (B.O.G.)

**13458**

**DEVELOPING NEW FUEL ELEMENTS.** J. L. Bernard, M. Englander, M. Gauthron, and J. A. Stohr (Commissariat à l'Énergie Atomique, Saclay, France). Nuclear Power 5, No. 48, 133-5(1960) Apr.

Research and development of metallic and cermet fuels for French reactors in use or envisaged are described. This investigation was conducted along two lines: the development and production, by the most economical means, of fuel elements for graphite-moderated gas-cooled reactors; and research work on fuel elements likely to be used in other types of reactors, such as water-cooled reactors, whether under pressure or not, boiling water reactors, advanced gas-cooled reactors, and sodium-cooled reactors. (B.O.G.)

**13459**

**FUEL ELEMENT FABRICATION AT ANNECY. SIGN SUPPLIES THE MARCOULE AND EDF REACTORS.** Nuclear Power 5, No. 48, 139(1960) Apr.

A description is presented of the fuel element fabrication plant at Annecy, France. This plant mass produces elements for the Marcoule and EDF reactors. Inspections are made at every stage of the fabrication process for appearance, dimensions, metallographic analyses of welds, impurity content of the uranium, chemical analyses of processing baths, x-ray analyses of finished elements, etc. Most of the operations were made entirely automatic to obtain maximum production and a strict identity of manufacturing conditions. (B.O.G.)

**13460**

**STATIC AND DYNAMIC MULTIPLICATION FACTORS AND THEIR RELATION TO THE INHOUR EQUATION.** E. E.

Gross and J. H. Marable (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 7, 281-91(1960) Apr.

The theory of the stable period of a fixed-fuel reactor is developed by considering the gross conservation of neutrons in the reactor. The resulting inhour equation directly relates the dynamic multiplication factor to the actual delayed-neutron fractions. The inhour equation may also be written in terms of the conventional multiplication factor if so-called "effective" delayed neutron fractions are introduced. The results are in agreement with those of the perturbation method. (auth)

#### 13461

ON THE THEORY OF THE DIFFUSION COOLING EFFECT IN HOMOGENEOUS AND HETEROGENEOUS ASSEMBLIES. W. Häfele and L. Dresner (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 7, 304-12(1960) Apr.

The flux distribution of a pulsed neutron experiment is expanded in terms of eigenfunctions with respect to both energy and space. The diffusion cooling constant is given exactly in terms of the eigenfunctions matrix elements, which are evaluated for the special case of a heavy gas moderator. The interaction of the cell and the assembly buckling in the structures is described. In addition to the normal diffusion cooling effect, a second cooling effect appears which is due to the neutrons which diffuse into the lumped absorbers. (auth)

#### 13462

NEUTRON ENERGY SPECTRUM MEASUREMENTS IN UN-MODERATED ASSEMBLIES. G. J. Fischer (Argonne National Lab., Lemont, Ill.). Nuclear Sci. and Eng. 7, 355-62(1960) Apr.

The neutron energy spectrum at the center of the dilute fast core of the coupled fast-thermal reactor ZPR-V was studied by use of fission chambers having electrodes quantitatively electrodeposited with  $U^{234}$ ,  $U^{235}$ ,  $U^{236}$  and  $U^{238}$ . Atomic fission ratios found with these four isotopes determine a four-group neutron energy spectrum which can readily be measured as a function of position in the core by use of suitable drive units. The same fission chamber procedure was used to study the equilibrium neutron energy spectrum in a natural uranium exponential column at Los Alamos. The results of measurements in these two spectra are shown and compared with theoretical predictions. The ZPR-V results are also compared to an analysis of this spectrum made by use of nuclear emulsions for the range 0.2 to 2.2 Mev. (auth)

#### 13463

DIFFUSION OF INTERMEDIATE ENERGY NEUTRONS INTO A THICK RESONANCE ABSORBER. H. H. Hummel and D. Meneghetti (Argonne National Lab., Lemont, Ill.). Nuclear Sci. and Eng. 7, 363-8(1960) Apr.

Diffusion of intermediate energy neutrons from a large moderated region into a thick resonance absorber is calculated with special reference to a coupled fast-thermal reactor. Boundary conditions at the interface between the two regions appropriate for a  $P-1$  calculation in the moderator are investigated. The transport approximation in the moderator is found to give good results for a hydrogenous moderator. (auth)

#### 13464

ON THE FAST EFFECT IN BERYLLIUM. P. G. Aline, P. E. Novak, and B. Wolfe (General Electric Co., San Jose, Calif.). Nuclear Sci. and Eng. 7, 392-4(1960) Apr.

The fast effect ( $n,2n$ ) in Be-moderated reactors is calculated from available experimental data on the ( $n,2n$ ) reaction from 1.85 to 14 Mev and certain assumptions about the

region below 4 Mev. The region above the ( $n,\alpha$ ) threshold of 0.71 Mev is broken into 18 neutron groups with the region above 6 Mev taken as the first group. All neutrons from the ( $n,2n$ ) reaction are assumed to be below the ( $n,\alpha$ ) threshold, so that transfer between groups occurs only due to elastic collisions. The elastic transfer cross sections are calculated, and the results are values of 1.03 and 1.19 for the fast effect for clean Be. After poisoning by the ( $n,\alpha$ ) reaction, however, the fast effect decreases and then becomes negative. Comparisons are made with other calculations and measurements of the fast effect, and the necessity of further data is pointed out. (D.L.C.)

#### 13465

Argentina. Comisión Nacional de Energía Atómica, Buenos Aires.

MEDICION DE REACTIVIDADES. Informe No. 17. (Measurement of Reactivities). Report No. 17. Juan A. Chamero. 1959. 17p.

The measurement of reactivities is based upon the response of a critical reactor to a perturbation. The method used is applicable to perturbations whose magnitude is out of the experimental range of Nordheim's relation. In a critical facility there are limitations which decrease the usefulness of the method of stable period. These limitations are the maximal neutron flux consistent with the permissible dose and the activation of the fuel elements. Measurements of negative and positive reactivities are explained. (auth)

## Power Reactors

#### 13466 ACNP-5922

Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee. PATHFINDER ATOMIC POWER PLANT CONCEPTUAL DESIGN STUDY OF CRBR QUICK-OPERATING PRESSURE VESSEL CLOSURE AND SELF-ENERGIZING SEAL TESTS. Final Report. R. G. Michel. Oct. 15, 1950. 178p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS.

With this are bound Appendix A: Allstates Design and Development Co., Inc., Milwaukee. CONCEPTUAL DESIGN STUDY OF A QUICK OPENING CRBR PRESSURE VESSEL CLOSURE. Appendix B: Koerper Engineering Associates, Inc., Milwaukee. QUICK OPENING CLOSURE FOR CRBR REACTOR VESSEL. Aug. 28, 1959. (KDM-AC-1011).

The work to determine the feasibility of using a quick-operating closure for the pressure vessel of the controlled Recirculation Boiling Reactor is described. An outline of the work performed and the conclusions made is given. Detailed results of the self-energizing seal-evaluation tests are given. (W.D.M.)

#### 13467 APAE-Memo-235

Alco Products, Inc., Schenectady, N. Y. SM-2 REACTOR CORE AND VESSEL REVIEW REPORT [FOR] AUGUST 25, 1959 TO DECEMBER 14, 1959. Dec. 24, 1959. 138p. Contract AT(30-3)-326. OTS.

The most adverse power distribution was revised based on a comparison of PDQ calculations and measurements made during the SM-2 flexible experiments. A review of the basic nuclear data and calculational models employed in the SM-2 nuclear analysis was made. A comparison between initial reactivity, hot-to-cold reactivity change, and xenon reactivity with experiment was made. Based on a revised power distribution, the core flow requirement was reestimated to be 7800 gpm. Tentative designs of the core support and fuel element structure were pre-



pared and evaluated for pressure drop and flow distribution. The ETR and MTR irradiation programs are summarized. The TIG process for welding elements is discussed. Specimens of  $\text{Eu}_2\text{O}_3$  dispersions in stainless steel were autoclave tested. Static deflection measurements indicated that a fuel element with cold rolled plates will have a deflection approximately 18% lower than annealed plates. Measurement of plate collapse on two elements indicated possible collapse in the range 140 to 164% of rated flow. Flow distribution and pressure drop tests were made for several core support structure configurations. Mockup experiments on the SM-2 initial cold, clean and SM-2 mid-life cores were completed. Limited power distribution and flux distributions were performed in the clean mockup. The hot-to-cold reactivity change was measured by aluminum displacement as \$8.90. The average  $B^{10}$  and  $U^{235}$  worth in the clean mockup was measured as 43 and 0.157¢/g. The reactivity effect of replacing control rod fuel assemblies by stationary fuel elements was measured in the clean mockup. Stuck rod positions were measured in the mid-life mockup. (For preceding period see APAE-Memo-223.) (W.D.M.)

13468 BAW-1170

Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.

LIQUID METAL FUEL REACTOR EXPERIMENT QUARTERLY TECHNICAL REPORT, APRIL-JUNE 1959.

62p. Contract AT(30-1)-1940. OTS.

Design and construction of all analog simulation circuits for the LMFRE-1 primary loop were completed. A preliminary study is underway to determine the technical and economic feasibility of a high-temperature, integral liquid metal fuel reactor (HTIR). The reactor, primary heat exchanger, and pumps are located in the same vessel; the fuel solution operating temperatures are relatively high, from 1100 to 1300°F. Data are presented on Croloy Loop corrosion and corrosion rates of Ta, Mo, and Be. Experiments to determine the release rate of  $\text{Po}^{210}$  from bismuth as a function of temperature, carrier gas, and surface area were completed. The ethylenediamine tetraacetate (EDTA) titration was successfully used to determine Th in Bi. Equipment was designed for the ETR Loop Offgas Study. The over-all system is designed to collect and prepare offgas samples for determination of Xe and Kr concentrations. Programs were issued for dispersion fuel development, fuel preparation, study of slurry fuel development, and modified fuel evaluation. Measurements on Assemblies CC, CD, and CE were completed, concluding a series of experiments that varied core height and end reflector thickness in order to measure axial buckling, axial reflector savings, and the effect of changing the core H/D ratio. For this series, the reflector regions are graphite,  $V_{\text{BI}}/V_{\text{C}} = 0.5$  (nominal), and  $N_{28}/N_{\text{BI}} = 1200 \times 10^{-6}$  (nominal) in the core region. (For preceding period see BAW-1152.) (W.L.H.)

13469 CF-59-8-140

Oak Ridge National Lab., Tenn.

CALCULATION OF RADIAL NEUTRON-FLUX DISTRIBUTION IN EGCR LATTICE CELL. T. K. DeBoer. Aug. 31, 1959. 8p. OTS.

The neutron flux distributions in an EGCR cell containing seven rod clusters of 2.0 and 2.6% enriched uranium oxide were obtained by using a one-velocity, one-dimensional P-3 solution to the neutron transport equation and adjusting fluxes in the fuel cluster in a manner which is consistent with previous comparisons of experimental and calculated distributions. Flux traverses in the outer rod

perpendicular to a diameter of the cluster are also presented. (auth)

13470 DP-465

Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.

HEAVY WATER MODERATED POWER REACTORS

Progress Report [for] January 1960. L. Isakoff, comp.

Mar. 1960. 41p. Contract AT(07-2)-1. OTS.

Approximately one-quarter of the construction and 85% of the firm design of the Heavy Water Components Test Reactor (HWCTR) were complete at the end of January 1960. Safeguards analyses of the liquid- $\text{D}_2\text{O}$ -cooled loop of the HWCTR showed that none of the accidents considered to date have serious potential. Exploratory tests of a device for quenching the steam that would be generated in the boiling- $\text{D}_2\text{O}$ -cooled loop of the HWCTR showed that a quencher could be designed to operate satisfactorily without excessive accompanying noise or vibration. Two Zircaloy-clad tubes of crushed, fused uranium oxide were cold swaged to a density of greater than 90% of theoretical. Several other cold-swaged oxide tubes clad with stainless steel were fabricated for irradiation specimens. Mechanical, hydraulic pressure, thermal- and pressure-cycling tests of tubular metallurgical joints between Zircaloy and stainless steel continued to show excellent properties. (For preceding period see DP-455.) (auth)

13471 KAPL-M-HS-12

Knolls Atomic Power Lab., Schenectady, N. Y.

EFFECT OF SHIP ATTITUDE AND SHIP MOTION ON PRIMARY COOLANT SYSTEM FLOW RATES. H. E. Stevens, Jr. Feb. 18, 1960. Appendix A: DERIVATION OF EFFECT OF ANGULAR ACCELERATION ON DRIVING HEAD IN A NATURAL CIRCULATION REACTOR. J. H. Pigott. Jan. 24, 1960. 32p. Contract W-31-109-Eng-52. OTS.

Analytical techniques for analyzing the effects of ship motion and attitude on the primary coolant system flow rates are presented. Design data for minimizing these effects are given. (C.J.G.)

13472 KAPL-M-NPA-9

Knolls Atomic Power Lab., Schenectady, N. Y.

MODEL AND EQUATIONS FOR DIGITAL ANALYSIS OF A MIXED NATURAL AND FORCED CIRCULATION POWER PLANT. A. J. Arker and T. R. Greene. Mar. 15, 1960. 43p. Contract W-31-109-Eng-52. OTS.

A model for digital transient analysis of a natural, forced, or mixed convection pressurized water reactor power plant is provided. The model and the equations are described with derivations and assumptions being included. The model represents the reactor, two primary coolant loops, pressurizer, secondary steam system, pumps, and hot and cold leg piping. The effects of a ship's motion are included. (auth)

13473 NAA-SR-Memo-4139

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

BURNUP STUDIES FOR THE U-10 w/o MOLY REFERENCE DESIGN FUEL ELEMENT LOADING OF THE HNPFCORE USING THE MARK A CONTROL ROD SCHEME. R. H. Davidson. July 20, 1959. 29p. OTS.

A study was conducted to determine the effects of fuel burnup on core reactivity and power distribution in uranium-10% molybdenum reference design fuel element loading in HNPFC. A prediction of uranium-235 burnup, plutonium production, and fuel exposure data are included. (J.R.D.)

**13474** NAA-SR-Memo-4736(Rev. A)

Atomics International Div., North American Aviation, Inc.,  
Canoga Park, Calif.

**STEAM CYCLES FOR ADVANCED ORGANIC REACTOR  
PLANTS.** G. R. Terpe. Dec. 10, 1959. 10p. OTS.

A study was conducted of high-pressure single and dual steam turbine cycles suitable for advanced organic reactor plants. Flow and temperature diagrams are included along with a tabular summary of calculations. It is concluded that since the dual cycle advantages decline with rising coolant temperature, it is not attractive for applications in future organic reactor plants. (J.R.D.)

**13475** NP-8565

New York Shipbuilding Corp., Camden, N. J.

**N. S. SAVANNAH, DRAFT OF FINAL SAFEGUARDS RE-  
PORT TEST, START-UP AND TRIALS, NEW YORK SHIP-  
BUILDING CORPORATION.** Apr. 6, 1960. 75p.

The N. S. Savannah program for testing, start-up, and initial operation of all reactor and propulsion components and systems is discussed. Definitions of test phases are given and various stages of the test program are outlined. A list of tests for the various reactor, propulsion, and other system components is included. (C.J.G.)

**13476** NYO-9057

Sanderson and Porter, New York.

**FUEL ELEMENT DEVELOPMENT PROGRAM FOR THE  
PEBBLE BED REACTOR.** Quarterly Progress Report  
[for] November 1, 1959 to January 31, 1960. 26p.  
Contract AT(30-1)-2378. OTS.

A variety of spherical uranium-graphite fuel elements for the Pebble Bed Reactor (PBR) was fabricated. Poor results with sintered alumina coated  $UO_2$  particles led to the development of alumina coating by vapor deposition, for which good results have been obtained. A variety of sub-surface metal, metal carbide, and ceramic coatings located between an unfueled graphite shell and the fueled core of a PBR fuel element was prepared and examined. Most of the materials and processes showed poor results. Excellent metal recoveries were achieved from the metal oxide-graphite system using the grind-leach technique of reprocessing. Test results on Si-SiC coated fuel elements showed good fission product retention in neutron activation tests, a self-welding tendency between adjacent spheres at 2500°F surface temperature, and no evidence of failure when an internal gas pressure of 300 psi was applied. Fission product release rates from a pyrolytic carbon coated specimen under low-level irradiation were obtained at 150 to 1900°F. The design of the in-pile loop to study the behavior of fission products escaping from PBR fuel elements was established. (C.J.G.)

**13477** ORNL-2907

Oak Ridge National Lab., Tenn.

**ARMY PACKAGE POWER REACTOR PROJECT ANNUAL  
PROGRESS REPORT FOR PERIOD ENDING JANUARY 31,  
1960.** Apr. 4, 1960. 46p. Contract W-7405-eng-26.  
OTS.

Nuclear calculations were performed to investigate the burnout behavior of 10,000-Mwd/ton Pu when used as the fuel for an SM-1 reactor. The reactivity lifetime curve was found to be relatively flat compared with that for the reactor fueled with  $U^{235}$  plus B burnable poison. The magnitude of B losses incurred during fabrication of SM-1 core I fuel plates was determined by chemical analyses of 18 fuel plates remaining from core I manufacturing. Results of analyses indicated that the average boron loss in core I fuel plates was 22.4%. Fabrication procedures were developed for incorporating a dispersion of 26 wt.%  $Eu_2O_3$

in elemental type 304 stainless steel directly at the end of the fuel-bearing section of a control rod fuel plate. Eight full-size control rod fuel elements containing  $Eu_2O_3$  internal flux suppressors were manufactured for service in core II of the SM-1 reactor. Studies to determine the mechanism of B losses from boron-stainless steel alloys during high-temperature heat treatment were continued. These studies led to a mechanistic hypothesis in which O has an important role. A loss theory is outlined in which B is converted to  $B_2O_3$ , which may then volatilize or react with any available moisture to form more volatile B compounds. The compatibility of zirconium diboride, boron nitride, boron carbide, and strontium hexaboride with type 304LB stainless steel was investigated. It was concluded that the selected compounds were unstable at the temperatures and times considered. Specifications and fabrication procedures were established for  $Eu_2O_3$ -bearing control rods for the SM-1 reactor. Eight absorber sections containing a homogeneous dispersion of 37 wt.%  $Eu_2O_3$  in type 304 stainless steel were fabricated for core II of the SM-1 reactor. Exploratory studies were initiated to evaluate more closely the effect of silicon on the chemical stability of  $Eu_2O_3$  in type 304 stainless steel. Mechanical properties of dispersions of mixed rare earth oxides in stainless steel were measured as a function of temperature for 30 and 50 wt.% oxide dispersions. Fabrication studies were initiated toward development of a B gradient control rod. Long-term corrosion tests of brazed joints and of defective fuel plates in high-temperature water were completed. Preliminary short-term corrosion tests were conducted in which deliberately defected  $Eu_2O_3$  specimens were exposed to high-temperature water. No dimensional changes were noted, but there was a leaching of the exposed  $Eu_2O_3$  particles. A postirradiation examination was made on SM-1 reactor core I fuel elements and absorber sections which had operated for 10.5 Mw yr. Although there had been no apparent operational difficulties, visual examination during a scheduled maintenance shutdown revealed what appeared to be a number of structural failures. Detailed examination of two absorber elements showed loss of core-clad bonding at the high-flux end of seven of the eight plates of the two assemblies, clad-frame separation in five plates, and clad failures in two plates. Two fuel elements (one stationary and one fuel element control rod) were examined, and no evidence of cracking was noted. Although a number of suspected cracks were reported in the preliminary examination, these suspect areas were found to be only superficial scratches. An analytical approach led to formulation of a theory of irradiation damage in  $UO_2$ -stainless steel dispersion fuels. (For preceding period see ORNL-2703.) (auth)

**13478** TID-5713

Duquesne Light Co., Shippingport, Penna.

**MONTHLY OPERATING REPORT, DECEMBER 1959.** 42p.  
Contract AT(11-1)-292. OTS.

A summary of activities is presented in sections on station activity schedule, operation, maintenance, refueling, test program, and training program. (For preceding period see AECU-4601.) (J.R.D.)

**13479** TID-5714

Duquesne Light Co., Shippingport, Penna.

**MONTHLY OPERATING REPORT [FOR] JANUARY 1960.**  
35p. Contract AT(11-1)-292. OTS.

A summary of activities is presented in sections on station activity schedule, operations, maintenance, refueling, test program, and training program. (For preceding period see TID-5713.) (J.R.D.)



**13480 TID-5756**

Duquesne Light Co., Shippingport, Penna.

CHARGING AND DISCHARGING OF DEMINERALIZER RESIN. SECTION V. SECOND PERFORMANCE. CORE I, SEED 1. Test Results DL-S-180 (T-612085). First Issue, Mar. 22, 1960. 4p. OTS.

The satisfactory flushing of the 1B radioactive waste disposal system ion exchanger of resin in the Shippingport Pressurized Water Reactor is reported. (C.J.G.)

**13481 TID-5757**

Duquesne Light Co., Shippingport, Penna.

CHARGING AND DISCHARGING OF DEMINERALIZER RESIN. SECTION VI. FIRST PERFORMANCE. CORE I, SEED 1. Test Results DL-S-180 (T-612085). First Issue, Mar. 22, 1960. 5p. OTS.

The satisfactory charging of the 1B radioactive waste disposal system ion exchanger (with 12.5 ft<sup>3</sup> of resin) of the Shippingport Pressurized Water Reactor is reported. (C.J.G.)

**13482 WAPD-BT-17(p.30-4)**

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

CALCULATIONS AND MEASUREMENTS OF XENON TRANSIENTS IN THE PWR. D. H. Jones. 5p.

During the reactivity lifetime of a power reactor, it is often necessary to calculate the reactor's ability to maintain criticality during a xenon transient resulting from a power reduction. A method is outlined for calculating critical control rod heights and control rod worths during xenon transients occurring throughout core life in a seed-blanket reactor. Calculations performed by this method are found to compare favorably with data measured during three xenon transients of the PWR at Shippingport. (auth)

**13483 WAPD-BT-17(p.35-47)**

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

HOMOGENEOUS BLANKET EXPERIMENTS. W. H. Hannum and J. P. Beall. 13p.

A series of experiments has been performed in a special assembly of PWR-1 blanket materials known as the "homogeneous blanket." From a direct evaluation of the diffusion equations, the gross flux shape in this assembly can be related to criticality parameters, and, thus, the adequacy of the present few-group constants can be deduced. A discrepancy between calculation and experiment is found, and this discrepancy is compared with various uncertainties of the calculational model. (auth)

**13484 WAPD-MRP-84**

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

PRESSURIZED WATER REACTOR (PWR) PROJECT TECHNICAL PROGRESS REPORT FOR THE PERIOD DECEMBER 24, 1959 TO FEBRUARY 23, 1960. 117p. Contract AT-11-1-GEN-14. OTS.

Power Plant Engineering: The design for installing 2" equalizing vent valves on air locks 2, 4, and 5 was completed. An evaluation of the failed main coolant pump No. 1-80-F-737 was completed. The design for installing combination ball check and manual stop valves on the boiler water level sight glasses, to prevent the escape of steam should a defective sight glass develop, was completed. The main coolant pumps No. 80 and No. 79 were modified by increasing the radial clearance of the impeller wear ring and by removing the upper labyrinth ring. A design for relocating the cooling water flow orifice 17-J4-17 was completed. Metallurgy: Preliminary data from the BETT 69-1 in-pile thermal conductivity cap-

sules indicate that the thermal conductivity of as-sintered ZrO<sub>2</sub> 34 wt.% UO<sub>2</sub> appears to decrease from an initial value of about 1.6 Btu/hr-ft-°F to about 0.7 Btu/hr-ft-°F after 17 days irradiation in an estimated perturbed flux of  $4 \times 10^{15}$ . The thermal conductivities of UO<sub>2</sub> and BeO 51 wt.% UO<sub>2</sub> fuel remained unchanged during this time. Examination of the two failed X-3-1 fuel plates and the two failed CR-V-m fuel plates showed that a definite burnup limitation exists for bulk UO<sub>2</sub> of about  $16 \times 10^{20}$  to  $21.5 \times 10^{20}$  fissions/cc at which point the fuel increases in volume about 4-5%. Irradiation of both fine and coarse dispersions of 28 wt.% UO<sub>2</sub> in BeO to exposures of about  $11 \times 10^{20}$  fissions/cc shows this material has very poor dimensional stability and poor fission gas retention ability. The fine particles dispersion showed approximately 4.8 times the thickness increase as did the coarse particles. Interim examination of a bulk B<sub>4</sub>C burnable poison plate irradiated in the HB-1 loop to about 60 at.% B<sup>10</sup> burnup showed a 17% increase in plate thickness. The technical feasibility of fabricating blanket receptacles with full length fuel channels and an integral cover plate by form rolling was established. Pack-pressure-bonding appears to be a suitable means of incorporating void volume in fuel compartments of oxide plates. High density (99% T.D.) and improved microstructures of B<sub>4</sub>C-SiC burnable poisons are achieved when small (2 micron) B<sub>4</sub>C particle size powder is used in hot pressing compacts. Measurements of the self-diffusion coefficients of uranium in UO<sub>2</sub> by the method of surface activity decrease were completed. Experiments on the diffusion of Xe<sup>133</sup> in Core 2-type UO<sub>2</sub> fuel platelets were completed. Diffusion anneals carried out at 1000°C on samples from the X-3-1 and the 14-28 irradiation tests show that the apparent diffusion coefficient for Kr<sup>85</sup> increases considerably with burnup. An average activation energy for thoron emanation in UO<sub>2</sub> was estimated to be 44 kcal/mole. An initial experiment on the release of helium from slightly irradiated B<sub>4</sub>C at 900°C resulted in a diffusion coefficient for helium of  $3.5 \times 10^{-8}$  cm<sup>2</sup>/sec. Physics: Calculated values for seed-blanket power sharing as a function of PWR-1 Seed 1 life were compared with measured data obtained from thermal instrumentation at Shippingport. Two-dimensional depletion studies in the PWR-2 "composite cell" geometry were completed for seed assembly configurations having different radial fuel zoning. An eighth core representation is being employed for a two-dimensional depletion calculation of PWR-2. An analysis of the effect on the axial power distribution of the nonuniform temperature distribution in an 8 ft PWR-2 core loaded with 295 kg of U<sup>235</sup> indicated that local variations in power density of as much as 15% may occur, relative to the distribution that would exist if the axial temperature distribution were uniform. A technique was developed which makes possible an approximately correct description of the neutron capture rate within small rectangular boron wafers in diffusion theory calculations. Seed peaking factors measured in a five-cluster slab of PWR-2 mock-up materials were measured and compared with calculated peaking factors obtained using the nuclear design technique in which the full core is represented in a detailed fashion. Measurements of the ratio of epithermal-to-thermal neutron radiative capture in U<sup>238</sup> were carried out in a plate-type geometry similar to that proposed for a PWR-2 blanket cluster. Measurements of the one-rod-withdrawn shutdown margin with 6 in. Cd-In-Ag control rods were completed. An irradiated natural UO<sub>2</sub> sample was measured in the RMF from 4 to 7200 hours following an exposure to 6300 MWD/T. Reactor Engineering: The Zr-Hf weld of an irradiated control rod replaced during refueling was tested to failure. Refueling progressed to

the point where all core components were replaced and seal welding of mechanisms, fuel ports, and instrumentation was 75% completed. Permissible power levels for operation of Seed 2 during transient xenon conditions were calculated. Flow tests were run on two subassemblies in the Critical Velocity Program to study flow induced deflection of fuel plates. The test results show small deflections below the theoretical "critical" velocities increasing with flow rates and more severe at the inlet to the subassembly. (For preceding period see WAPD-MRP-83.) (auth)

#### 13485 YAEK-164

Westinghouse Electric Co. Atomic Power Dept., Pittsburgh.

#### YANKEE CONTROL ROD PROGRAMMING STUDY.

Maurice Robkin. Aug. 1959. 100p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

A study was made of various rod withdrawal sequences for the Yankee Power Reactor. Account is taken of the effect of spatial variation of material due to the basic core structure and to the arrays of control rods and followers on the maximum to average power density,  $F_Q$ , and the enthalpy rise hot channel factor,  $F_{\Delta T}$ . The results are presented in both tabular and pictorial form. A control rod program is selected on the basis of optimum, i.e., lowest, values of  $F_Q$  and  $F_{\Delta T}$ . (auth)

#### 13486

THE FUTURE OF NUCLEAR ENERGY AS A NEW ENERGY SOURCE. [PART] II. E. Duis. *Atom u. Strom* 5, 17-20 (1960) Feb. (In German)

Questions on the planning, construction, and economics of nuclear power plants are briefly reviewed as an introduction to a survey of the integration of nuclear energy into the power industry. The resources of fissionable materials are indicated. (J.S.R.)

#### 13487

ECONOMICS OF A CENTRAL POWER STATION WITH A PRESSURIZED WATER REACTOR. E. Demierbe. *Electrotechniek* 37, 429-32(1959). (In Dutch)

#### 13488

THE WESTINGHOUSE NUCLEAR POWER DEVELOPMENT PROGRAM. R. L. Witzke. *Electrotechniek* 37, 433-5 (1959). (In English)

The development programs on the pressure tube reactor and fluidized bed reactor are reviewed. (Reactor Centrum Nederland)

#### 13489

THE P.W.R. IN THE POWER FIELD. A. Point. *Electrotechniek* 37, 453-6(1959). (In English)

The use of the pressurized water reactor in a nuclear power plant is discussed relative to plant design, auxiliary systems, operational safety, reactor vessel, nuclear core, steam generators, pressurizer, canned motor pumps, and the vapor container. (Reactor Centrum Nederland)

#### 13490

HERO—DESIGN AND CONSTRUCTION. *Nuclear Eng.* 5, 150-53(1960) Apr.

Details for the construction of the zero-energy HERO reactor are given, and the differences in its design and the AGR design are pointed out. The details on the graphite stack, fuel handling, control, gas circuits, ventilation and cooling, and flux and temperature measurements are included. (D.L.C.)

#### 13491

CHANGES IN CALDER FUEL ELEMENTS UNDER IRRADIATION. V. W. Eldred, A. Stuttard, and J. Skinner (United Kingdom Atomic Energy Authority, Sellafield, Eng.). *Nuclear Eng.* 5, 160-63(1960) Apr.

Over 1,000 selected Calder Hall elements were investigated. Special attention was given to 25 elements with can failures. The failures were analyzed and it was found that failure due to irradiation is more likely to occur in elements operating at the lowest temperature, where the ductility of the can is least and the fuel most susceptible to irradiation growth. (D.L.C.)

#### 13492

FUEL HANDLING AT BERKELEY. *Nuclear Eng.* 5, 164-8(1960) Apr.

The design and construction of the fuel-handling equipment for loading Berkeley reactors under load are discussed. Instead of one or two multi-purpose machines, 5 or 6 specialized units will be installed on the charge face. Design details are given for the skirts (support structures), chute machine, charge/discharge machines, fuel element loader, control rod actuators, and observation and removal equipment. (D.L.C.)

#### 13493

THE SAFETY OF NUCLEAR POWERED MERCHANT SHIPS. J. Neumann (Yarrow and Co., Ltd., Eng.). *Nuclear Eng.* 5, 169(1960) Apr.

The rules for design and construction of nuclear-powered merchant ships proposed by the Ministry of Transport (Great Britain) are interpreted with special reference to rules concerning the location of propulsion turbines in the containment structure, coolant leaks, and rates of reactor power change. (D.L.C.)

#### 13494

NUCLEAR SHIPS. PROPOSED M.O.T. RULES FOR DESIGN AND CONSTRUCTION. *Nuclear Eng.* 5, 170-71(1960) Apr.

Rules proposed by the Ministry of Transport (Great Britain) for the design and construction of nuclear-powered merchant ships are given. They cover the following considerations: containment of reactor coolant, dangerous reactor materials, prevention of and resistance to fire, reactor operation under rolling sea and high list, removal of decay heat, standby equipment, reactor shutdown arrangements, controls, maneuvering ability, radiation shielding under reactor operation and servicing, independent source of electrical power, shock resistance of shutdown and cooling equipment, and alternative source of propelling power. (D.L.C.)

#### 13495

POLARIZATION IN  $C^{12}(pp)$  SCATTERING. J. E. Evans and M. A. Grace (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Nuclear Phys.* 15, 646-52(1960) Mar. (2). (In English)

Measurements were made of polarization in  $C^{12}(pp)$  scattering at  $60^\circ$  (lab.) in the energy range 2.3 to 4.3 Mev. The results are significantly different from those derived from a phase-shift analysis and can be explained by the extreme sensitivity of the polarization to small changes in the phase shifts. The experimental values then indicate a correction for the d-wave splitting. (auth)

#### 13496

THE SECOND NUCLEAR POWER STATION. M. Bienvenu, Boris Saitcevisky, François Bourdillat, Claude Tourgeron, Roger Millot, M. Lamiral, and Louis Laurent (Electricité



de France, Paris). Nuclear Power 5, No. 45, 118-23(1960) Apr.

A description is given of the design characteristics of the French second nuclear power station, EDF-2. The station is designed for 198 Mw(e) out-put, for 195°C inlet and 365°C exit temperatures, a neutron flux at the core center of  $3 \times 10^{13}$  n/cm<sup>2</sup>/sec, and CO<sub>2</sub> gas coolant of 100 metric tons. The commissioning of the station is scheduled for 1962. (B.O.G.)

### 13497

#### FUEL HANDLING ON THE PLUTONIUM REACTORS.

G. Derome and A. Ertaud. Nuclear Power 5, No. 48, 127-9(1960) Apr.

The fuel handling methods used at Marcoule reactors, G2 and G3, are discussed. All operations of the refueling machine are automatically controlled from a central station, are viewed by means of closed circuit television, and are heard through microphones located at strategic points. A study of the difficulties encountered in the loading and unloading of the G2 and G3 has caused new efforts to be concentrated toward developing new and better means to perform this operation. (B.O.G.)

### 13498

THE FISSION GAS PROBLEM FOR MOBILE FUEL FAST REACTORS. Frederick G. Hammitt (Univ. of Michigan, Ann Arbor) and Evan C. Kovacic and Frederick J. Leitz (Atomic Power Development Associates, Inc., Detroit).

Nuclear Sci. and Eng. 7, 327-35(1960) Apr.

The problems that might result from the release of fission gases in mobile fuel fast reactors are considered for two types of mobile fuel systems; namely, a molten alloy fuel system of the type to be used in the Los Alamos Molten Plutonium Reactor Experiment and a paste fuel system of the type being developed by the Atomic Power Development Associates, Inc. It is shown that the volume of fission gases generated in fast reactors operating at high-power density would supersaturate such fuel systems in minutes or less. An examination of the physical conditions in the reactor core and an evaluation of the phenomena responsible for bubble formation result in the conclusions that neither fuel system will sustain a significant degree of supersaturation and that bubble formation will most likely occur at a solid-liquid interface rather than in the bulk of the liquid. The effects of bubble formation in each system are considered, and these are seen to involve partial blanketing of the heat transfer surfaces, overheating of the fuel, particularly of the paste fuel, equilibrium dilution of the fuel with significant loss in reactivity, sudden displacement of the fuel with subsequent rapid changes in reactivity, and blocking of narrow fuel ligaments and orifices. Preliminary experiments, using supersaturated solutions of carbon dioxide in water and in water-glass bead beds are reported, which verify some of the analyses which are made regarding the location of bubble formation and the growth of bubbles. The flow characteristics of pastes in tubes and the behavior of gas bubbles in such flow systems are discussed in the light of experiments which were conducted using a simulant system of air/glass beads/water. (auth)

### 13499

RELATIONSHIPS BETWEEN REACTIVITY CHANGES, BUCKLING CHANGES, AND PERIODS IN A HEAVY WATER REACTOR. B. S. Finn (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nuclear Sci. and Eng. 7, 369-76(1960) Apr.

Period-reactivity relationships were measured in the PDP, a large D<sub>2</sub>O-moderated reactor fueled with natural

uranium. The measured relationships were found to correspond almost exactly to those predicted from the delayed neutron parameters measured by Keepin for fission neutrons and by Bernstein for photoneutrons. Satisfactory agreement was also observed between values of the migration area obtained from a measured reactivity-buckling relationship and those obtained as the sum of the separately measured values of the thermal diffusion area and the neutron age. (auth)

### 13500

#### CONSIDERATIONS IN THE DESIGN OF A NUCLEAR

ROCKET. John J. Newgard and Myron M. Levoy (Thiokol Chemical Corp., Denville, N. J.). Nuclear Sci. and Eng. 7, 377-86(1960) Apr.

The design of a prototype nuclear rocket is described. For practical systems using uranium-loaded graphite for fuel elements within a graphitic core structure, and hydrogen as core coolant and propellant, it is possible to achieve specific impulses of at least 800 sec. The following items are discussed: (1) design of the reactor core, reflector, and nuclear controls for a prototype design; (2) nuclear, heat transfer, and fluid flow considerations for typical design; and (3) reactor perturbations caused by fuel element ejection, corrosion-erosion, and hydrogen density changes. Some radiation hazards are considered. Nonreactor aspects of the rocket such as hydrogen handling and the coupling of the reactor to the rocket system are indicated. (auth)

### 13501

AEC PUTS TOGETHER A LONG-RANGE POWER REACTOR PROGRAM. Nucleonics 18, No. 4, 71-82(1960) Apr.

A digest of the Atomic Energy Commission's long-range power reactor program, destined to provide nuclear power economically, is presented. It is a condensation of the detailed plans for research, development, and reactor construction, complete with timetables and approximate finding levels. The reactor concepts investigated were: pressurized-water, boiling-water, organic-cooled, sodium-graphite, gas-cooled (enriched fuel), fast-breeder, aqueous homogeneous, and heavy-water-moderated. This program concentrates on large power reactors because it is in large sizes that nuclear power plants can most readily prove economic. The key problems for each of these eight reactor concepts are discussed with proposed criticality dates for existing or scheduled reactor construction. Fuel development during this period must be keyed to cheaper fabrication and operation at higher temperatures and burnups. This is presented for ceramic and metallic fuels. (B.O.G.)

### 13502

INTRODUCTION TO NUCLEAR ENGINEERING. New York, Simmons-Boardman Publishing Corporation, 1959. 516p. \$16.00.

An analysis of the factors which make up the total cost of nuclear power and how variations in their value may affect the over-all cost structure is made in an "Introduction to Nuclear Power Costs," by Arnold Rochman. Other selections contained are: "Elementary Nuclear Physics," by W. K. Mansfield; "Nuclear Reactor Theory," by J. J. Syrett; "Reactor Heat Transfer," by W. B. Hall; "Nuclear Reactor Shielding," by J. R. Harrison; "Nuclear Reactor Control and Instrumentation," by J. H. Bowen and E. F. O. Masters; and "Steam Cycles for Nuclear Power Plant," by W. R. Wootton. The above six selections have also been issued as separate monographs in the Temple Press series "Nuclear Engineering Monographs," and have been previously indexed in NSA, Vol. 12, abstract numbers 10935,

11949, and 12336 and Vol. 13, abstract numbers 16575, 16574, and 10707, respectively. (C.J.G.)

### 13503

KERNENERGIEANLAGEN. (Nuclear Energy Installations). P. A. Petrow. Berlin, Veb Verlag Technik, 1959. 279p.

A textbook is presented with chapters on basic concepts of nuclear physics, nuclear reactions, physics of nuclear reactors, operation of reactors, materials for the core, design and construction of nuclear energy installations, and production of electric power reactors. Appendixes are included on: calculation of a reactor, thermal neutron cross sections, monogram for determining the functional value of  $\sin x$  and  $\cos x$ , and the nuclear fuel prices in the USA. (T.R.H.)

## Production Reactors

### 13504 CEA-BIB-5

France. Commissariat à l'Énergie Atomique, Paris. DESCRIPTION DES PILES ÉTRANGÈRES, SURGENÉRATRICES, A NEUTRONS RAPIDES. PROBLEMES PARTICULIERS LIÉS AU CONTRÔLE. (Description of Foreign Fast-Neutron Breeder Piles. Special Problems Connected with Control). J. C. Arlaud. 1959. 51p.

The main characteristics of the fast piles (DFR, EBR-2, and EFFBR) are grouped in comparative tables. The text describes the solutions adopted for each pile to meet the common problems of construction and operation. 34 references. (auth.)

### 13505 HW-63533

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

NPR SINGLE PASS DECONTAMINATION. G. E. Neibaur. Jan. 20, 1960. 5p. Contract AT(45-1)-1350. OTS.

Decontamination studies on the New Production Reactor (NPR) were performed. Under ideal laboratory conditions, the NaOH-KMnO<sub>4</sub> and Turco-4512 cycling processes effectively removed 28-day film from carbon steel in 2 cycles of 1 minute in each solution (total of 4 minutes). The cycling of decontaminating chemicals appeared to be more effective than a single contact process with each solution. (C.J.G.)

## Research Reactors

### 13506 BMI-1429

Battelle Memorial Inst., Columbus, Ohio

THE BMI-16 RECIRCULATING GAS LOOP INSTALLED AT THE ETR. Joseph V. Baum and Gerald A. Francis. Mar. 18, 1960. 45p. Contract W-7405-eng-92. OTS.

A developmental program was conducted to provide an in-pile loop facility for use in evaluating gas-cooled-reactor fuel subassemblies. The program included the design, construction, and installation of a recirculating gas loop which is located in a 6 by 6-in. facility in the aluminum reflector of the ETR. The loop system was designed to recirculate the primary nitrogen coolant at flow rates up to 0.9 lb per sec and pressures up to 200 psia. It will accept fuel subassemblies up to 36 in. in length and 2.26 in. in diameter with specimen power generation up to 150 kw. The maximum coolant temperature at the specimen outlet is set at 1500°F. The loop system includes the in-reactor section, the machinery, the control system, and the specimen-handling apparatus. Salient features of the re-entrant system include an aluminum pressure wall in the in-reactor section, static gas insulation between the reactor coolant and the circulating loop

gas, and a controllable rate of heat exchange between the specimen inlet- and specimen outlet-gas channels in sections of concentric counterflow piping. The three blowers in the system feature grease-lubricated bearings and water cooling. The complete system was tested out of pile and is now installed in the ETR. (auth)

### 13507 CF-59-1-24

Oak Ridge National Lab., Tenn.

PREDICTION OF THERMAL-NEUTRON FLUXES IN THE BULK SHIELDING FACILITY FROM LID TANK SHIELDING FACILITY DATA. A. D. MacKellar. Jan. 12, 1959. 35p. OTS.

Predictions of the thermal neutron fluxes to be expected near the Bulk Shielding Reactor were made on the basis of Lid Tank Shielding Facility experimental data transformed to the BSR geometry. The predicted fluxes are higher than the measured fluxes by 12 to 22% for distances closer than 60 cm from the reactor, but they are essentially in agreement for larger distances. (auth)

### 13508 HMI-B-6

Hahn-Meitner-Institut für Kernforschung Berlin.

ERGÄNZUNGEN ZUM SICHERHEITSBERICHT FÜR DEN BERLINER FORSCHUNGSREAKTOR BER. (Supplement to the Safety Report for the Berlin Research Reactor BER). Sept. 1959. 90p.

A supplement to report number IKB-C-B2 (NSA, Vol. 13, abst. No. 8241) on the safety of the Berlin Research Reactor is presented. It contains the experience and results obtained during the test period between first criticality and operation at full power (50 kw), and gives information needed for an evaluation of the safety of the reactor. The report covers reactor management organization, a description and discussion of the installation, the reactor hall and ventilation system, effluent water and waste handling, environs monitoring, and the maximum credible accident and its effects. (T.R.H.)

### 13509 NAA-SR-3337

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

OMRE FUEL REMOVAL AND SHIPPING EQUIPMENT. P. J. Mallon, D. S. Duncan, R. C. Noyes. Apr. 1, 1960. 48p. Contract AT-11-1-GEN-8. OTS.

A portable assembly for handling and shipping OMRE fuel elements is described and details of its operation are given. Problems of heat transfer and radiation shielding are discussed, and detailed analyses are presented. (auth)

### 13510 NP-8550

Naval Postgraduate School, Monterey, Calif.

AN AUTOMATIC STARTUP SYSTEM FOR THE LIVERMORE WATERBOILER NUCLEAR REACTOR (thesis). Joseph L. Randolph. 1959. 148p., 1 illus.

Design calculations and experimental test results for an automatic startup system for the Livermore Water Boiler are presented. Automatic startup from near source level (below the period meter range) to full power (500 watts) was demonstrated with this system. Multidecade logarithmic power control also was demonstrated in the range 0.05 watts to 500 watts. Demanded period is continuously variable in the range  $\infty$  to 10 seconds. Demanded power level is continuously variable from 0.05 watts to 500 watts. Photographs of the control chassis and a schematic diagram of the control system are included. The Livermore Water Boiler power transfer function was measured in the frequency range 0.1 rad/sec to 157. rad/sec by the pile oscillator technique. Calculations and results of the measurement are included. (auth.)



**13511 ORNL-2892**

Oak Ridge National Lab., Tenn.

**SURFACE TEMPERATURES OF IRRADIATED ORR FUEL ELEMENTS COOLED IN STAGNANT AIR.** J. F. Wett, Jr. Apr. 6, 1960. 15p. Contract W-7405-eng-26. OTS.

A problem which arises during shipment of irradiated fuel elements is that of the maximum surface temperature which might be reached when the element is air-cooled by natural convection only. In an investigation of this problem, several irradiated Oak Ridge Research Reactor (ORR) fuel elements were raised into a hot cell, and their temperature traverses were measured. Correlations between maximum surface temperature and the irradiation history of the element were made by using the Way-Wigner formula and the data of Perkins and King. It can be concluded that a decay of 19 hr is sufficient to keep the maximum surface temperature of an ORR fuel element, in air, below a dangerous level. It is felt that the results, while not directly applicable to elements other than those from the ORR, can assist in establishing orders of magnitude and will provide a basis for more generalized extensions. (auth)

**13512 ORNL-2898**

Oak Ridge National Lab., Tenn.

**PHOTONEUTRONS AND THE CONTROL OF A POOL-TYPE REACTOR.** A. L. Colomb. Apr. 18, 1960. 9p. Contract W-7405-eng-26. OTS.

The components of the total thermal neutron flux at the detector location were analytically studied for different distances between the reactor and the detector and for different subcritical states of a pool-type reactor. It is shown that, although a direct photoneutron coupling between the reactor and the detector does not exist, an indirect coupling due to the fission product gamma rays takes place. This coupling is found to be proportional to the multiplication of the subcritical reactor. An experiment, in which the total thermal neutron flux is measured with two different concentrations of deuterium in the water surrounding the detectors, confirmed the validity of the analytical results. (auth)

**13513**

**THE LOW FLUX REACTOR.** R. A. van der Laken (Reactor Centrum Nederland, Hague). *Atoomenergie* 2, 33-5(1960) Mar. (In Dutch)

A reactor of the Argonaut type was purchased by the RCN. A brief description is given of this reactor, which is called the Low Flux Reactor (LFR). (tr-auth)

**13514**

**RESEARCH REACTORS.** Borisas Cimblelis (Comissão Nacional de Energia Nuclear, Rio de Janeiro). *Fóton* 1, No. 4, 2-14(1959) Mar. (In Portuguese)

A survey is made of the characteristics and utilization of research reactors. The factors governing the selection of the reactor type are reviewed. (J.S.R.)

**13515**

**RESEARCH REACTORS. A SURVEY OF CURRENT DESIGNS. PART II.** *Nuclear Eng.* 5, 154-9(1960) Apr.

A survey of current designs for research reactors is given. Detailed descriptions are included for the 10 kev CONSORT, the 30 Kw NTR, the 10 Kw Pool Test Reactor, the 30 Mev General Electric Test Reactor, American Machine and Foundry 1 kw and 5 Mev pool reactors, the 5 Mev MERLIN, the Miles Hivolt sub-critical assembly, and the Nuclear Chicago Model 9,000 assembly. (D.L.C.)

**13516**

**CONSORT—NEW U.K. RESEARCH REACTOR, JOINT DE-**

**SIGN OF FIRM AND UNIVERSITY.** *Nuclear Energy* 14, 152-3(1960) Apr.

A newly designed research reactor is described which provides a most effective compromise between the designs, ease of fuel-handling, compactness, and good accessibility to the core for experimental facilities of the "swimming-pool" and "enclosed-tank" types of water-moderated reactors. The CONSORT is rated at 10/kw with a flux of approximately  $3 \times 10^{10}$  thermal neutrons and  $2 \times 10^{10}$  fast neutrons/cm<sup>2</sup>/sec. This reactor was originally proposed for the expansion of the training and research facilities at the Imperial College. The reactor cost is approximately £50,000. (B.O.G.)

**13517**

**BACTERIAL "INFECTION" OF THE OMEGA WEST REACTOR.** Eric B. Fowler, C. W. Christenson, Edward T. Journey, and William D. Schafer (Los Alamos Scientific Lab., N. Mex.). *Nucleonics* 18, No. 4, 102; 105(1960) Apr.

For most of the summer of 1958 the Omega West tank-type research reactor suffered from a bacterial "infection". More than  $10^8$  organisms could be found in each milliliter of reactor tank water. The bacterium—of the genus *Pseudomonas*—was probably able to multiply because the partially disintegrated anion resin supplied carbon and nitrogen for growth. The combination of resin fragments and bacterial growth caused a marked turbidity in the water, so much so that a 1,000-watt lamp could be seen only dimly at a depth of 4 ft in the reactor. Both problems—turbidity and bacterial growth—were solved by combined purging, intermittent operation, filtration, and change of resin. Felt-pad filters were replaced by metallic filters to avoid the possibility of feeding organic matter to the reactor water. Bacteria have not reappeared. (auth)

## WASTE DISPOSAL AND PROCESSING

**13518 HW-62035**

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

**SOIL COLUMN STUDIES WITH RADIOSTRONTIUM. I. EFFECTS OF TEMPERATURE AND OF SPECIES OF ACCOMPANYING ION.** J. L. Nelson. Sept. 22, 1959. 12p. Contract AT(45-1)-1350. OTS.

Soil column diameter was found to have no effect on Sr<sup>2+</sup> breakthrough curves where concentration of Sr<sup>2+</sup> in effluent divided by concentration of Sr<sup>2+</sup> in influent is plotted vs. number of column volumes. The column volume is defined as the total space occupied by packed soil in the column. Soil column length, on the other hand, had a pronounced effect on the shape of the breakthrough curves. Breakthrough curves of long columns had a steeper slope than those of short columns and the curves cross near the C/C<sub>0</sub> = 0.5 point. This indicates that crib capacity predictions based on short laboratory columns are conservative from this standpoint. Attempts are being made to fit equations to the data that will accurately describe the changes in breakthrough curve slope with different column lengths. (auth)

**13519 HW-62598**

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

**DECONTAMINATION OF THE KER RUPTURE EXPERIMENT LOOP TEST SERIES B—TESTS NO. 1 AND 2.**



R. D. Weed. Nov. 2, 1959. 6p. Contract AT(45-1)-1350. OTS.

The first series of tests in the KER-REP-1 loop proved that a fission product contaminated loop could be decontaminated to a safe level for contact maintenance. A Turco process is compared to a dual cycle of the APACE process. The dual cycle was about 2.5 times more corrosive than the Turco process. The decontamination factors were of the same order of magnitude for both processes. (W.D.M.)

**13520** HW-63048

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

RESEARCH AND DEVELOPMENT ACTIVITIES, RADIOACTIVE WASTE FIXATION QUARTERLY PROGRESS REPORT [FOR] JULY-SEPTEMBER 1959. D. W. Pearce, ed. Sept. 15, 1959. 22p. Contract AT(45-1)-1350. OTS.

Installation of all equipment and piping for the fluidized bed calciner prototype was completed. Heat transfer characteristics of the product from a fluidized bed waste calciner were determined. The operation of a radiant-heat spray calciner is described. Formaldehyde-killed Purex-type waste with various additives and TBP-25 waste were tried in the melt furnace at about 900°C. The results are shown. Thermal conductivities of several kinds of as-produced spray calcined powder were determined by measuring radial temperature drop in an axially-heated cylinder of powder. The fixation of radioactive waste by mineral reactions is being investigated. (For preceding period see HW-61635.) (W.L.H.)

**13521** HW-63930

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

SOIL COLUMN STUDIES WITH RADIOSTRONTIUM. II. EFFECTS OF SOIL COLUMN LENGTH AND DIAMETER. J. L. Nelson. Feb. 15, 1960. 16p. Contract AT(45-1)-1350. OTS.

Temperature can have a significant effect on the soil sorption of radionuclides. Species of accompanying ion determines the direction and amount of the effect. If the ion accompanying  $\text{Sr}^{2+}$  is  $\text{Na}^+$ , increased temperature improves  $\text{Sr}^{2+}$  sorption while if the accompanying ion is  $\text{Mg}^{2+}$  or  $\text{Al}^{3+}$ , the opposite is true. Where  $\text{Ca}^{2+}$  is the accompanying ion no measurable effect is seen. Where  $\text{Cs}^+$  is the trace ion, elevated temperatures would always decrease soil sorption. At equal temperatures,  $\text{Ca}^{2+}$  and  $\text{Al}^{3+}$  are strong competitors for exchange sites while  $\text{Na}^+$  is a weak one. About 20 times the crib capacity could be expected for neutralization of waste with caustic rather than with limestone. (auth)

**13522**

RADIOACTIVE WASTES. IV. METHODS OF TREATMENT OF RADIOACTIVE WASTES. W. Eveleens (Reactor Centrum Nederland, Hague). Atoomenergie 2, 36-43 (1960) Mar. (In Dutch)

A survey is given of the methods used for the treatment of gaseous, liquid, and solid wastes. Centralization of the treatment of radioactive wastes is, in certain circumstances, recommended for reasons of safety and economy. (auth)



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